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THE EFFECT OF ACTION WORKOUTS ON AIRCRAFT MISSION CAPABILITY MEASUREMENTS

THESIS

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THESIS

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Michael P. Allison

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Abstract

Previous studies concerning quality improvement and the Action Workout Process attempted to define and describe the difficult concept of quality. A logical next step is to study to what extent implementation of a quality improvement program, such as ACC's Action Workout Process, positively or negatively affects performance factors within an Air Force organization.

This study focused on exploring the fundamental question of whether there was, as a result of the Action Workout, a noticeable, statistically verifiable, positive or negative change in the mission capability of aircraft assigned to the units carrying out this quality improvement initiative.

Research questions were developed and data analysis conducted to determine if the effects of the Action Workout could be quantified and measured and if the Action Workout was an effective means of improving aircraft performance. While the results of this study did not unequivocably endorse the Action Workout Process, the results do indicate performance at several bases was enhanced after implementation of this quality improvement process. Using these results as a baseline, future researchers can now take the next step – a fuller understanding and quantification of the effects of quality improvement processes, such as the Action Workout, on organizational performance.

THE EFFECT OF ACTION WORKOUTS ON AIRCRAFT MISSION CAPABILITY MEASUREMENTS

I. Introduction

Background

As the Air Force enters the twenty-first century, continued efforts are underway across the major commands to reduce costs and develop more efficient methods of accomplishing work. One such method, championed by the Air Combat Command (ACC), is a process known as the Action Workout. The Action Workout is ACC's primary tool for attacking waste in their critical work processes (Action, 1997) and has experienced great success in meeting its goals – "significant reduction in cost, defects, waste, or overall cycle time" (DOA,1997: 5).

Measuring the Long-Term Effects of Action Workouts, an Air Force Institute of Technology research thesis developed by Lieutenant John Malone, examined the validity of the Action Workout Process in terms of the overall quality of major aircraft inspection processes (Malone, 1998: 8). Investigating aircraft inspection results from three ACC bases, Malone concluded there was "at least plausible evidence suggesting that quality enhancements can be realized as a result of Action Workouts" (Malone, 1998: 46-47). It should be noted, however, that the data used in this study were highly subjective and the results obtained were not statistically significant.

Problem Statement

While the results of Malone's research lend credence to the stated objectives of the Action Workout Process, they do not address a fundamental question that should be asked of any process involving the Air Force and its assigned aircraft: "what is the impact of the Action Workout Process on aircraft mission-capability measures?" This research explores this fundamental question. Specifically, as a result of the Action Workout, was there a noticeable, statistically verifiable, positive or negative change in the mission capability of aircraft assigned to these units?

Research Questions

To effectively determine if there was a definitive change in the mission capability of assigned aircraft, three questions need to be addressed:

1. Can the effects of the Action Workout be quantified and measured?
2. Was the Action Workout an effective means of improving aircraft performance?
3. What issues affect the relationship between the Action Workout Process and changes in the mission capability of aircraft?

Scope

This research effort uses only commonly available aircraft performance data and is unclassified. The methodologies and models used and developed by this research do not examine all the possible performance characteristics of the particular aircraft, nor does it study the extent to which quality initiatives have sustained themselves at the

respective units. Because many Air Force organizations deploy quality initiatives and manage quality initiatives at different levels, and because quality education and training is situationally and contextually dependent, this research effort may have drastically variable results.

Additionally, the population of interest for this study is limited to United States Air Force units possessing Phase or Isochronal aircraft inspection responsibilities that have implemented an Action Workout Process within the last four years. The research focuses only on activities, or units, meeting this criterion. While many facets of aircraft performance (effectiveness) could be explored, this research is confined to investigating the extent to which the selected unit's mission capability measurements have been altered as a result of the Action Workout Process.

Five units were selected for analysis based on the variety of their airframes and the timing of their Action Workouts. Timing was essential since it was a requirement of the study that there be available a full 24 months of data following the initial arrival of the Action Workout team to the unit of analysis. Table 1 lists each of the units involved along with their locations, aircraft inspected, and dates of the Action Workout.

Eight units were selected as control groups for the study. Due to the type of aircraft examined at each of the units under analysis, control groups were not available for each of the five units in the study. Because of their uniqueness the 55 WG and the 552 ACW do not have control groups, but the remaining three units do. Table 2 below lists each of the control group units along with their locations and aircraft. The dates of analysis correspond to the dates for similar aircraft in Table 1.

Table 1. Units Used for Research

Unit	Base	Aircraft	Date of AWO
366 WG	Mountain Home	F-15C/D	25-29 March 1996
55 WG	Offutt	RC-135	29 July – 2 August 1996
57 WG (66 RQS)	Nellis	HH-60	12-16 August 1996
552 ACW	Tinker	E-3	4-8 November 1996
355 FW (Ops)	Davis-Montham	A-10	19-23 May 1997

Table 2. Units Used for Research

Unit	Base	Aircraft
1 FW	Langley	F-15C/D
33 FW	Eglin	F-15C/D
57 WG	Nellis	F-15C/D
347 FW	Moody	HH-60
49 FW	Holloman	HH-60
23 WG	Pope	A-10
57 WG	Nellis	A-10
347 WG	Moody	A-10

Finally, because of the subjective nature of quality ratings, no attempt will be made in this research project to determine performance differences as they correlate to quality differences found in earlier studies of aircraft inspections and Action Workouts. Therefore, this study is best viewed as parallel research rather than a complementary or follow-on study to the work of Malone.

Limitations

Two limitations constrain this research project. They are time and space and organizational adherence to quality improvement.

1. Time and Space. This study examines the effects of Action Workouts conducted on unit inspection sections and their relationship to aircraft mission capability measurements. The timing of the Action Workouts, based on experimental design parameters (explained in Chapter III, Data Collection), made it impossible to include the efforts of all organizations. Instead, only aircraft inspection sections conducting the Action Workout Process before June, 1997 are included in the study.
2. There is no attempt to quantify the quality improvement efforts at each of the organizations under study. This limits the research effort because there are no accurate means to determine if the organization under study is maintaining any efficiency gains developed during the Action Workout.

Assumptions

Five major assumptions are followed in this research:

1. The Action Workout generated a definitive change in the way these bases accomplished their inspection programs.
2. Bases accomplishing the Action Workout have "stayed the course," with no noticeable changes in their adherence to the quality initiatives they adopted.
3. Statistical data necessary to accomplish this study will be readily accessible.
4. Three years is a sufficient length for data collection. "It is expected that 3 years is an average time period to expect to see valid accomplishments and Quality improvements" (DoD, 1989).
5. The continuous improvement brought about by the Action Workout Process has a direct impact, positive or negative, on unit aircraft performance factors.

Definitions

The following definitions are provided to assist the reader:

Abort Rate: A subjective measure reflecting the percentage of aircraft missions that end prematurely and must be reaccomplished, either in the air or on the ground due to an aircraft malfunction or discrepancy (ACC, 1995).

Air Combat Command (ACC) Quality Management and Innovation Squadron (QMIS): Unit tasked with enhancing ACC mission performance and increasing productivity. Plans, organizes, and coordinates Action Workout activities across ACC (ACCQMIS, 1998).

Benchmarking: Process used to improve organizational quality and performance through exploration of and cross-comparison with similar and dissimilar organizations.

Brainstorming: A group technique for generating ideas quickly. Uses non-attribution to ensure the free-flow of ideas within the group.

Break Rate: The percentage of landing aircraft that were unavailable for immediate retasking, and therefore require repair to undertake additional mission assignments (ACC, 1995).

Cross-Functional Team: A team comprised of individuals from different organizational units brought together to solve problems using a systems approach.

Customer: Any internal or external entity for whom a good or service is provided.

Malcolm Baldridge National Quality Award: Annual award recognizing excellence in quality achievement and quality management among American companies.

Mission Capable (MC) Rate: The number of aircraft available to meet at least one of their units wartime missions, measured as a percentage of total aircraft available (ACC, 1995).

Paradigm: An overall concept accepted by most people in an intellectual community, because of its effectiveness in explaining a complex process, idea, or set of data (Webster's, 1994).

Performance Measures: Numbers used to reflect unit logistic performance and identify upcoming support problems. Help to gauge the logistics readiness of various aircraft types, but are not to be used as competitive measures or as a report card of who is the best (ACC, 1995).

Quality Air Force (QAF): The Air Force's system (during the timeframe examined in this study) for implementing the tenets of total quality management. A top-down approach for continuous improvement everywhere in the Air Force.

Summary

As the Air Force undergoes the various changes brought about by reduction in forces and the uncertainty following the end of the Cold War, it must continue to find ways to improve processes and reduce costs. In order to react to these changes in both manpower and fiscal responsibility, ACC has adopted the Action Workout Process. The Action Workout Process is a fundamental part of ACC's transition into the twenty-first century. Nevertheless, questions remain as to the effects of the Action Workout Process on a unit's ability to perform its mission.

In the following chapters, this thesis analyzes several organizations that have implemented the Action Workout Process in their aircraft inspection sections and attempts to determine the effect of this implementation on aircraft mission performance. Chapter II examines the most current literature in this field of study. The methodology of the study is examined in Chapter III, with analysis of why it was chosen and how it was implemented. Chapter IV contains the results of the study as well as an analysis of these results. Finally, Chapter V discusses the findings and makes suggestions for future research.

II. Literature Review

Introduction

This literature review examines previous research in the areas of quality improvement and performance. This review will determine the extent to which quality improvements have negatively or positively impacted performance in both the public and private sector. After a thorough examination of these factors, the information will be used as a foundation for building this study's methodology and as a guideline for analyzing this research project's data.

Before I can discuss the operational effects realized after an Action Workout, it will be necessary to accomplish several fundamental steps. First, some key words must be operationally defined. Additionally, the theory behind the current professional understanding of the Action Workout Process should be fully explored. This exploration must look at all areas of the process, and its environment. Finally, since quality is at the very heart of the Action Workout Process, a brief overview of quality improvement and how it affects organizational performance will be discussed

Definitions

Action Workouts. Action Workouts, as discussed herein, were developed by the ACC Quality Directorate (ACC/QI). After looking at several quality improvement models, "ACC/QI benchmarked a technique called Action Workout, used by General Electric to dramatically increase production and lower costs by eliminating waste"

(Strader, 1995: 45). The Air Force defines the Action Workout as a process "used to create more output with less input by reducing set-up time, incorporating work standardization, preventive maintenance, scheduling, and methodology improvements" (Action, 1997).

Quality. Quality has always been a difficult concept to understand and define. Throughout the last half-century several noted scholars have attempted to categorize quality using various descriptions and methodologies. Most notable amongst these are the works of W. Edwards Deming (1986 and 1993), Joseph M. Juran (1988 and 1992), Philip Crosby (1979 and 1984), and David A. Garvin (1984).

"Two Americans were instrumental in teaching the Japanese quality control concepts. Dr. W. Edward Deming taught statistical quality control, and at a later date, Dr. Joseph M Juran taught the management of quality control" (Leep and Johnson, 1998: 15). Dr. Deming, educated as a mathematician and physicist, began analyzing quality in the 1930's. During this time he realized generally accepted methods of management should be replaced by statistical control techniques. Using these statistical analyses would allow managers to make decisions based on a systematic process rather than production-based intuition. After World War II, Deming took his management techniques to Japan, where they were adopted wholeheartedly. In his book Out of the Crisis, Deming describes the processes he introduced to the Japanese and the fourteen points (see Table 3) required for implementation of a program of quality management. Failure to faithfully implement any of these, according to Deming, will result in the failure of the quality improvement process (Deming, 1986: 151).

Table 3. Deming's Fourteen Points (Deming, 1986: 23-24)

1. Create constancy of purpose toward improvement of product and service.
2. Adopt the new philosophy.
3. Cease dependence on inspection to achieve quality.
4. End the practice of awarding business on the basis of price tag alone.
5. Improve constantly and forever the system of production and service.
6. Institute training on the job.
7. Institute leadership.
8. Drive out fear.
9. Break down barriers between departments.
10. Eliminate slogans, exhortations, and targets for the workforce.
11. Eliminate work standards and management by objective.
12. Remove barriers to pride of workmanship.
13. Institute a vigorous program of education and self-improvement.
14. Take action to accomplish the transformation.

Joseph M. Juran approached the concept of quality from a different perspective based primarily on his background in engineering and law. He defined quality as (1) product performance that results in customer satisfaction and (2) freedom from product deficiencies, which avoids customer dissatisfaction. A shorthand expression that conveys both meanings is "fitness for use" (Juran, 1988: 4-5). Rather than examining the organization as a whole, Juran looked into the product or service the organization

provided. Through implementation of quality at the product level, quality at the organizational level would quite naturally follow. Rather than inspecting out quality problems, Juran said managers should find the quality problems in individual products and redesign them at the product level. He divided his quality management into what he called his quality trilogy: quality planning, quality control, and quality improvement. Combining this trilogy into a single managerial approach will result in a reduction of quality cost over time (Juran, 1992: 14).

Philip Crosby points out that quality is conformance to requirements; nonquality is nonconformance (Crosby, 1984: 64). With this simple approach as his foundation, Crosby used his extensive background in corporate America to begin writing and teaching about quality management. His Management Maturity Grid (see Table 4), allows Crosby to determine the stage a particular company has reached in terms of quality management maturity.

Once a company finds where it fits into the quality grid, it can then implement Crosby's 14 steps of quality improvement (see Table 5). Each of these steps, according to Crosby, will enable an organization to move farther and farther to the right on the grid until they eventually pass through Wisdom and reside in Certainty (Crosby, 1989: 25-40). Only here, in Certainty, can an organization be sure it is conforming to a quality approach from the bottom up.

Table 4. Crosby's Quality Management
Maturity Grid (Crosby, 1979: 38-39)

Measurement Categories	Stage I: Uncertainty	Stage II: Awakening	Stage III: Enlightenment	Stage IV: Wisdom	Stage V: Certainty
Measurement Understanding And Attitude					
Quality Organization Status					
Problem Handling					
Cost of Quality As Percentage Of Sales					
Quality Improvement Actions					
Summation of Company Quality Posture					

By far the most comprehensive attempt to define quality appeared in an article by Harvard University's David A. Garvin (1984). Instead of trying to pigeonhole quality into a single definition, Garvin created five separate approaches to defining quality. The first of these he called the transcendent approach. From this perspective, quality is a universally accepted absolute, easily recognizable to all. The second approach is the product-based approach, where quality is exactly measured based on certain ingredients or attributes. The third definition is the user-based approach. Highly subjective, this approach depends upon the user's personal attitude about quality. The manufacturing-based approach is Garvin's fourth definition of quality. As long as an item is exactly in accordance with the requirements, then it is high quality based on this approach. The last

Table 5. Crosby's Fourteen Step
Program (Crosby, 1994: 99)

Step 1. Management commitment.
Step 2. Quality improvement team.
Step 3. Quality measurement.
Step 4. Cost of quality evaluation.
Step 5. Quality awareness.
Step 6. Corrective action.
Step 7. Zero-defects planning.
Step 8. Supervisory training.
Step 9. Zero Defects Day.
Step 10. Goal setting.
Step 11. Error cause removal.
Step 12. Recognition.
Step 13. Quality councils.
Step 14. Do it all over again.

way Garvin describes quality is through use of the value-based approach. This approach is based entirely on the cost of an item in comparison to its ability to accomplish its assigned task. Garvin points out that these multiple definitions help to keep both marketing and manufacturing within an industry happy (Garvin, 1984: 25-29), but it is also applicable outside the private sector and can help in the understanding of implications based on the results of the Action Workout.

It is clear from the work of these authorities that quality is a capricious entity, at best. No single definition explains what quality is or what quality represents, but each represents at least some aspect of the overall meaning of this difficult concept. In this study, quality improvement per se, is not the main concern; quality improvement in terms of its effect on performance is a primary concern however, and is measured by a rating comprised of various mission capability measurements.

Mission Capability Measurements. Changes in profits and stock prices are used to determine performance effectiveness in the private sector, but other, more creative measures need to be used in the military. For the purpose of this Air Force research project, performance will be equated to Mission Capability Measurements. Mission Capability Measurements will be defined as statistics reflecting the ability of a squadron, group, or wing to fulfill its stated mission requirements, or to "hack the mission." Mission-Capable (MC) Rate, Abort Rate, and Break Rate will be used to determine the effectiveness, from a mission standpoint, of the Action Workout Process. These rates will be combined to develop an overall RATE used to measure an organization's ability to meet their mission.

The Action Workout Process

As described in Table 6, the Action Workout is "a five-step process that is a high energy, barrier free, concentrated effort to eliminate waste, increase productivity and improve the processes in a work center" (DOA, 1997: 4).

Table 6. Action Workout Process (DOA, 1997: Attachment 2)

Step 1: Identify Opportunity. The opportunity for an HQ ACC Action Workout Team must be one where the commander feels there is a reasonably high potential for significant reduction in cost, defects, waste, or overall cycle time. Once the candidate process has been selected, the unit commander formally invites the HQ ACC Action Workout team to begin Step Two.
Step 2: Site Visit. Designed for the HQ ACC Team to provide training to the unit on the Action Workout concepts. During this step, the critical path for the process is identified and the key sub tasks are targeted for improvement.
Step 3: Unit Preparation. During this step, the unit collects data on the process as it is currently being accomplished to establish a baseline on which all improvement actions will be measured during the HQ ACC Action Workout Team event.
Step 4: Action Workout Event. This is a high-energy, 5 day event where the process owners attack waste, reduce defects, and improve the quality of the process.
Step 5: Follow-On Actions. This is the process improvement follow-through phase.

By adhering to this five-step process ACC is bringing a quality perspective to bear once again in the Air Force, where quality improvement awareness has historically fluctuated wildly between apathy and enthusiasm. It is becoming increasingly clear that quality is no longer applicable only to the manufacturing industry. Many firms and industries, both public and private, are beginning to stress the management of quality in all phases and aspects of their businesses. They are implementing this through adherence

to the critical factors of Quality Management (Saraph, 1989: 810). The primary factors, in their relationship to the Action Workout Process, are training, process management, quality data and reporting, and employee relations. It is evident that each of these factors is reflected in the five-step process and lend themselves to the implementation of continuous improvement as a mindset within ACC.

"The Continuous Improvement Process was conceived, developed, and brought to maturation in the United States" (Schroeder, 1991: 67); therefore, it is only natural it be used to improve processes within, arguably, the most identifiable symbol of the United States – the Armed Forces. To ensure this continuous improvement within the Action Workout Process, ACC has targeted seven primary sources of waste and inefficiency on each event. They are overproduction, queue and wait time, transportation and conveyance, rework, excessive inventory, redundant processing, and excessive motion (Action, 1997). By identifying and eliminating these sources of waste, ACC and their Action Workout Process hope to improve organizations one step at a time.

Quality Improvement

In addition to Malone's focused study of the quality improvements brought about through utilization of the Action Workout Process, several other studies have examined the effects of quality initiatives on organizational performance in a more broad sense.

Several of these studies have shown that Total Quality Management (TQM), a concept adopted by the Air Force within the last few decades, is very effective in improving quality (Sterman, 1997: 503-504). "Experts on organizational innovation view TQM as a new organizational technology that enables the organization to use its human

and other physical assets more productively" (Hendricks and Singhal, 1997: 1262). Based on the writings of W. Edwards Deming, TQM has been studied endlessly and the results are very decidedly in favor of it being an effective method of improving quality within an organization, but does it have an impact on performance?

Since Deming published Out of the Crisis in 1986, several studies have analyzed TQM in terms of the lessons learned from its implementation. In 1994, Richard J. Schonberger described three lessons learned over the past decade from the sometimes-fitful attempts of American corporations to institute TQM. He first pointed out that grassroots changes in the human resource management department are essential for successful integration of the tenets of TQM. Next, he described how these changes must be intertwined with the changes brought about in the total-quality package. And finally, development of new human resource policies must occur in concert with process changes, not as a precursor or follow-on. Only through adherence to these three steps can TQM be effectively implemented in the United States (Schonberger, 1994: 109).

While several researchers have focused their attention on the lessons learned during the last decade, many other researchers are drawing conclusions concerning the size and types of organizations where TQM is best employed. This is an especially important consideration when examining the results of quality improvement processes within an organization such as the U.S. Air Force, where its vast size and its role as a service provider can become confounding factors.

Ahire and Golhar (1996) looked for differences in the implementation of TQM in large and small organizations. Using survey results from 499 motor vehicle parts plant managers, Ahire and Golhar (1996: 1) developed three statistically substantiated

conclusions: (1) TQM results in better product quality, (2) firm size did not play a role in operational differences, and (3) TQM is implemented equally well at both small and large firms (Ahire and Golhar, 1996: 1).

Just as an analysis of size is important, so is one involving the sector in which the organization conducts business. Schonberger describes TQM as a management concept that has "scurried across the landscape – first in production, then in office support areas, and finally in the service sector" (Schonberger, 1992: 17). Once in the service sector, TQM has shown no signs of slowing. In fact, it has gained momentum and is reaping rewards for companies through increased quality and, in some cases, recognition through presentation of the Malcolm Baldridge National Quality Award.

While many researchers and writers expound on the virtues of the total quality movement, some question whether America has the wherewithal to adhere to the basic principles detailed by Deming, Juran, and Crosby. With success stories widely publicized and failures well concealed (Crouch, 1990: 45), it becomes difficult to get an accurate accounting of where organizations collectively stand in their quest to effectively incorporate quality into their business practices.

Research has shown that failure on the part of organizations to implement TQM effectively can be attributed to four 'myths' of quality. First, the idea that education is the key to implementation is correct, but misunderstood. Too many companies believe setting up a quality training program, in and of itself, will effectively deal with the quality improvement question. This could not be further from the truth. Training your workforce about quality makes them more aware of the bad quality around them, but does not take the necessary steps required to fix the processes that are producing it.

Second, the false impression that results can not be attained quickly is a myth, perpetrated to some extent by those advocating the endless stream of quality training available to today's organizations. Third, too many organizations believe total buy-in from the workforce is essential to effective implementation. This is contrary to common wisdom in regards to management's responsibility for and control over all processes within an organization. Finally, due to the large amount of capital expended on quality improvement initiatives, quality 'gurus' make false claims that theirs is the only effective system to implement. Nothing could be further from the truth, quality is a generic approach applicable to any industry and any size company (Crouch, 1990: 46).

Quality improvement is a complex initiative with equal numbers of supporters and opponents to the tenets it espouses. Several studies, as noted by Sterman (1997), have detailed how quality improvement initiatives have successfully increased the quality of the products and services of the organizations adopting TQM. Additionally, the research conducted by Schonberger (1992) and Ahire and Golhar (1996) have laid the groundwork for future quality aspirants by covering the lessons learned, studying quality in various size organizations, and describing the opportunities available to both the manufacturing and service sectors. Finally, through analysis of 'tripwires' encountered during implementation, Crouch (1990) has simplified the process of setting up a quality program. Taken together, these studies improve an organization's chances of implementing a successful quality improvement program, but how exactly is a successful quality improvement program measured and accounted for?

Measuring for Quality

According to James H. and James S. Harrington, "to measure is to understand, to understand is to gain knowledge, to have knowledge is to have power. Since the beginning of time, the thing that sets humans apart from the other animals is our ability to observe, measure, analyze, and use this information to bring about change" (1995; 416). As Carol Gabor (1998), Employee Development Specialist for the Minnesota Department of Transportation, states, "To understand what makes us productive or non-productive, we must understand our own work processes. All processes can be measured, insofar as they can be described, tracked and monitored." From their earliest inception, continuous improvement programs have promoted the use of quality metrics to ensure everyone from upper-level management to the lowest-level worker was aware of both the goals of the program and its daily progress. This is especially true in the military. According to Dr. William Cunningham of the Air Force Institute of Technology at Wright-Patterson Air Force Base:

> Achieving Air Force logistics excellence requires three things: (1) a clear understanding of customer service requirements and a strategy for meeting those requirements, (2) tools and techniques for measuring quality and productivity, for identifying needed improvements, and for choosing among available improvement actions, and (3) a framework and process for carrying out improvements across the various organizations involved.
>
> (Cunningham, 1998)

Initially, two of the strengths of the continuous improvement program's metrics was its simplicity of use and its ease of understanding. Simple flow diagrams and job breakdown charts were used to help everybody in the process become more involved and develop "buy-in" to the program's overall goals. Using this methodology, continuous

improvement programs such as Total Quality Management became the foundation upon which the explosively aggressive and efficient economy of Japan was built. "In the 1980's, the Japanese successfully produced high quality products at relatively low cost, thus capturing a large share of the global market in critical industries such as automotive and electronics" (Ahire and Golhar, 1996: 1). With this Japanese expansion came an awareness by management professionals of the amazing efficiencies created through adherence to a process and customer-oriented system.

Measurements are an effective means for guiding an organization if used correctly, but they can be destructive if used improperly (Harrington and Harrington, 1995: 418). This has become a problem in both the public and private sector. Management's allegiance to quality has resulted in a deluge of quality metrics – to the detriment of the organization. Reducing the number of metrics and improving the ones used will have a profound effect on the implementation of quality within an organization (Main, 1994: 129-133).

Not only are the number of metrics being used a problem, but also what the metrics are measuring. All too often management develops metrics with no bearing whatsoever on productivity in the workplace. While they are most definitely measuring something, it is not a productive measurement. As Harrington and Harrington point out, "the organization's measurement system is a meter of what the organization feels is important. It should reflect the organization's basic principles and identify how the organization is performing related to all of its stakeholders' values" (1995: 417). If the metric is not telling somebody how he or she can improve their production or reduce their costs, then it is not an effective measure.

This is a problem in both the public and private sectors. In an interview with Connie Allison, merchandise manager at Sam's Club Wholesale Warehouse, improper metrics was determined to be a very real problem. She describes her company's private trucking firm as "inefficient and expensive," with no discernible advantage over the for-hire alternatives available to many other companies. She points out that when this subject is discussed with transportation management, their reply relies on metrics that do not accurately measure the variable of customer (individual store) satisfaction. These transportation managers point out that their distribution centers operate at a 99.9% efficiency, but they fail to realize that what they are measuring has nothing to do with the products that are reaching their customers. Instead, their metric measures their efficiency at moving freight across their docks, which is of little concern to the store manager receiving pallets full of the wrong products. This misguided allegiance to cross-dock efficiency has caused the transportation managers to lose sight of what the overall goal of the entire Walmart Corporation is – to make money through improved performance (Allison, 1999).

Accounting for Quality

Failure to measure the right data is an issue in the Air Force even more so than in the private sector. This is primarily due to the antiquated method of cost accounting used in the Air Force as compared to the method used in the private sector. "The cost models used in the military tend to disaggregate costs which, in reality, exist only in the aggregate" (Swartz, 1999). What this means is that the military has a tendency to break out costs to individual units of production (manpower). They assume that labor is totally

interchangeable and the process on which the labor works has no serial interdependence. This could not be farther from the truth, labor costs in the military are aggregate; they are paid for in a lump sum, basically configured as a period cost. The Air Force incorrectly attempts to allocate these costs to individual processes when, in reality, they do not apply their resultant man-hour savings to any other part of the organization. When they determine they no longer need an individual unit of production to accomplish a certain job they wrongly conclude they have saved money by eliminating it, but this could not be farther from the truth.

For example, when the Air Force conducted an Action Workout at Dyess Air Force Base in May 1995, Air Force managers concluded they had "produced incredible labor hour savings" (Dyess, 1995: 47), but had they really? While it is true they reduced the number of hours needed to accomplish a certain task, they had not eliminated any personnel from the military as a result. All they had done was to move the people who had been accomplishing the job over to another tasking in the same unit. This, however, did not keep them from attaching a dollar figure to the savings they were reaping from their improved process. It could be argued there were no real man-hour savings produced as a result of these Action Workouts. Instead, the accomplishment resulted in the movement of a cost-allocated unit of resource from one part of the unit to another with no real savings at the aggregate level.

In the private sector, writings and research have examined this phenomenon and its relationship to quality enhancement within an organization. Goldratt and Cox (1986), in their book <u>The Goal: A Process of Ongoing Improvement</u>, describe one organization where adherence to these antiquated methodologies was disastrous. Only after examining

and altering their cost-accounting techniques were the managers of this organization able to start reaping the benefits of their quality improvement programs. Additional research, as described by Olian and Rynes (1991: 319), details how improper financial measures were ineffective at capturing quality improvements. With cycle time, inventory requirements, defects, and costs all decreasing over a specified period, traditional accounting practices showed unfavorable changes in labor utilization and overhead costs over the same period. This leads management to believe their improvement policies are not working when, in fact, they are.

These deceptive accounting principles are nothing new. H. Thomas Johnson points out that accounting, as it is used today, evolved in the early 1950's and has not changed to any great degree since then. He continues to describe how these principles encourage managers and executives to incorporate bad habits in the management of their companies, and since these principles are used in business schools and top-level management, they have perpetuated themselves (1992: 18). This methodology, in conjunction with the blind belief that quality performance metrics are an accurate measure of unit productivity, will continue to cause problems with the apparent contradictions they create.

Quality Improvement and its Effect on Performance

Several studies have examined the effects of quality initiatives in the private sector. The primary thrust of these studies has been an analysis of the effects of quality improvement programs on overall quality within an organization. This is a complex issue considering the inherent difficulty associated with the measurement of quality and the

problems encountered with attaching a dollar value to the changes in this measurement. Additionally, it fails to answer the critical question: is a successful quality improvement program measured by its ability to improve the quality of the products or services produced, and/or is it measured by its ability to improve overall performance?

Dean M. Schroeder examined several companies from the past 100 years, including National Cash Register in 1894 and Lincoln Electric in 1946, which implemented the concepts of the Continuous Improvement Process. He determined they had effectively reached the aim they had set out for, namely they had designed a system whose natural equilibrium was constant improvement and change (1991: 67-70). He concluded by asking the question, "How can a company that does not have such a program expect to compete with one that does?" (Schroeder, 1991: 67).

To help explain the relationship between quality improvements and performance within an organization, David A. Waldman (1994) began an examination of work performance using a system-focused perspective. Rather than comparing statistics relating to workplace improvement, Waldman attempted to create a method of modeling work performance in organizations employing TQM. Through the integration of various TQM writings, the author was able to link unit-level work performance with individual improvements in a system-focused manner. This system, the author contends, provides more information to the manager than any one of several statistical analyses ever could. Waldman concludes his study by stating:

> Perhaps greater theoretical and empirical attention to the combined effects of person and system factors would help management researchers to develop a better understanding of performance issues. In doing so, management theory and research might become more applicable to

> organizations in terms of helping them to enhance their performance.
>
> (Waldman, 1994: 531)

Is additional theory and research necessarily the avenue to making total quality work (in terms of improved performance) within an organization? According to Deming's quality chain -- as quality improves, costs decrease, productivity improves, market share increases, businesses prosper, and number of jobs increase (Deming, 1986: 1). In response to this assertion, there are conflicting reports addressing these phenomena and recent research has tended to flail around rather than to adequately address this question with hard numbers.

One such study, by Olian and Rynes (1991), determined that implementation of total quality requires a relinquishing of some of management's most cherished traditions and assumptions. "For [TQM] to be successful, organizational processes must be altered, different forms of information must be attended to, and various stakeholder groups must be persuaded to buy into the process" (Olian and Rynes, 1991: 306). This statement appears to agree with Waldman, but it is not supported through empirical research. Instead, it attempts to make conclusions based on past writings and theory rather than substantiation of conclusions through data collection.

The quality outcomes described by Malone (1998), Schroeder (1991), Sterman (1997), and others are well substantiated in the research literature, but they failed to answer a very fundamental question. While several companies, and the United States Air Force, claim to have reaped a great many benefits through quality improvement processes, have these continuous improvement processes had any effect on profitability or, in the case of the Air Force, production and mission accomplishment.

Researchers are now turning their focus to determining the effects of quality initiatives on profitability and production. A recent study by Kevin B. Hendricks and Vinod R. Singhal attacked this problem and stated "the success and failure of Total Quality Management programs should be judged against results from rigorous empirical evidence" (1997: 1259). While many studies claim that "Total Quality Management is not as effective as previously believed, it might even damage firm performance, and it is a fad that has run its course and is losing popularity" (Hendricks and Singhal, 1997: 1259), these same studies do not support their claims with credible data.

Hendricks and Singhal examined 400 firms that had won quality awards between 1983-1993 to determine if an effective TQM program actually improves working performance (it should be noted that the award process for these 400 companies was not reliant on profit in any way). Their results are conclusive, but not overwhelmingly so. They determined that operating income and sales growth, on average, showed an increase in these firms, but evidence was not as conclusive as studies examining the improved quality within similar firms (1997: 1258-1274).

In 1995, an Australian study attacked this issue using 75 small-to-medium sized firms (Chapman, et al.: 1995). The study used a survey, consisting of questions covering five broad quality improvement indicators, to measure the degree to which quality was being implemented in the selected organizations. The five indicators were: (1) Strategic integration, (2) Deployment/involvement, (3) Customer-focused planning, (4) Measurement and benchmarking, and (5) Innovation and Continuous Improvement. The validity of the responses was tested and links between quality management and business performance indicators were determined. The three financial performance indicators the

authors used in their research were earnings on shareholders funds (EOSF), return on total assets (ROTA), and labor productivity ratio (LPR).

After tabulating the survey responses and comparing them to the financial performance indicators, the authors drew their conclusions. They determined that the LPR was considerably more sensitive to Continuous Improvement initiatives than either ROTA or EOSF. Additionally, they determined that linking TQM initiatives with Quality and Strategic Advantage was far more likely to result in positive changes in the financial indicators than if either one was implemented individually (Chapman, et al.: 1995: 443-445).

A separate Australian study, conducted by Shadur and Rodwell (1995), analyzed the quality/performance relationship in regards to Information Technology companies. Their study involved 37 respondents to a survey asking questions covering six topic areas: TQM, continuous improvement, Just-in-Time (JIT), quality circles, team-based work, and statistical process control (SPC). The results of their study were mixed. They determined that JIT and SPC were positively correlated to productivity in the organizations under study; however, there was not a correlation between TQM and productivity. This lack of significant findings for the other quality systems (TQM, continuous improvement, quality circles, and team-based work) confirmed to the authors that it is the hard processes that count. "That is, the more philosophical variables based on 'mindsets,' such as TQM, did not differentiate the high from the low productivity companies" (Shadur and Rodwell, 1995: 209).

Not all of the research on the effects of quality improvement programs on performance was conducted in Australia. Several studies were developed and carried out

over the last few years in the United States. Three of these studies were conducted by Flynn, Schroeder, and Sakakibara (1995), Forker, Mendoza, and Hershauer (1997), and Easton and Jarrell (1998).

Flynn, et al. were a little more creative compared to previous studies in this area. Rather than exploring the effects of quality programs on performance at the business level, where implementation can vary greatly between organizations, they attempted "to fill the gap by studying quality management at the plant level" (Flynn, et al., 1995: 660). Analyzing 42 U.S. plants, the authors built a model based on the responses from a questionnaire mailed to several different workers within each of the plants.

The output of their model resulted in very different conclusions. Their research showed that reduced "process flow management practices" (an emphasis on preventive maintenance and reduction of process flow variance) lead to better quality market outcomes, which seemed to be counterintuitive. On the other hand, a lower percentage of items requiring rework followed intuition by having a significant effect on quality market outcomes (Flynn, et al., 1995: 682-683). Both of these items were shown to profoundly affect performance and exhibited cross-correlational attributes. The authors concluded their study by detailing their refined model and suggesting future research, but it should be noted that no hard evidence relating implementation of quality improvement processes with performance were determined.

While Flynn, et al. examined quality at the plant level, Forker, et al. (1997) set out to determine the effects of TQM implementation on the supply chain. With previous research focusing primarily on the manufacture of finished goods, this study attempted to determine how performance was affected by introduction of quality practices to the

supply chain. Using the electronics components industry, whose reliance on quality has increased greatly in recent years due to increased competition, the authors surveyed several suppliers of a major U.S. company. Once collected, the survey results were used to determine the level of TQM implementation at the respective suppliers and were compared to actual data from the parent firm used to evaluate its suppliers. With defective parts per million (DPPM) as the benchmark statistic, Forker, et al. began their analysis.

The analysis of the data resulted in the following finding: "Hypothesis 1, predicting a simple positive linear relationship between extent of TQM implementation and quality performance, was not supported" (Forker, et al., 1997: 1690). The research did not conclude at this point however, by grouping different analyses and using objective data, the authors were finally able to conclude there was a relationship between TQM and quality performance (Forker, et al., 1997: 1696). This relationship, however, was not supported by the original self-reported data from the electronics company suppliers, and therefore is open for discussion.

Easton and Jarrell conducted the most comprehensive study by far detailing the relationship between quality improvement program implementation and improved performance in 1998. Analyzing 108 firms that implemented TQM between 1981 and 1991, they compared "each firm's performance to a control benchmark designed to capture what the performance would have been without TQM" (Easton and Jarrell, 1998: 251). Using the criteria set forth in the Malcolm Baldridge National Quality Award, Easton and Jarrell developed their working definition of quality to be used throughout their study. To determine the impact of TQM implementation, the authors examined

financial data for the five years following the introduction of the quality improvement program and compared it against analysts' forecasts for the same time period.

The results show a positive correlation between TQM introduction and improved financial performance, as measured by "net income, operating income, and inventory scaled by measures of firm size based on sales, assets, or number of employees" (Easton and Jarrell, 1998: 267). The study exhibited clear evidence of improved performance on the part of these organizations in terms of both accounting variables and stock returns (Easton and Jarrell, 1998: 298). The authors conclude the study by tempering their conclusions. They point out that the companies under study were very diligent in their implementation of TQM and, because of this zeal, the results of their study may not be generalizable to all other firms. Additionally, since this study was conducted during an economic growth period, some of the results may be skewed due to the expected effects brought about by an expanding economy.

Summary

In the Air Force, there was a tremendous push to implement the teachings of Deming and others in the early to mid 1980s. This push became a microcosm of what had occurred in the private sector over the last 35 years. The Air Force went from the idealistic implementation of the system, with the optimism accompanying it, through its early successes, and eventually to the apathetic point we find ourselves in today. ACC's Action Workout is one of the last vestiges of true quality improvement processes within the military, and it is the goal of this research project to determine if it is resulting in the performance improvements it presaged.

"Recent evidence suggests the connection between quality improvement and financial results may be weak" (Sterman, 1997: 503). While this may be true, it is not without its reasons. Primary amongst these is the fact that several measurements of quality performance do nothing of the sort. "Performance indicators should be based on profit rates or the social rate of return" (Papps, 1995: 56), not on difficult to understand or incorrect measures of performance. Additionally, the propensity of organizations to poorly manage their quality improvement programs and inadequately implement them can severely handicap their successful introduction.

This is a major concern within the Air Force. Since management and organizational structure is always changing, maintaining continuity in a continuous improvement process, such as an Action Workout is not always easy. Changes in people bring changes in philosophy, motivation, and management styles. It is difficult for people to maintain "buy-in" to a process when they are used to systems and processes changing every time the management changes, be it at unit or command level.

As Schroeder states, "It is easy to adopt the tools and management mechanisms of a Continuous Improvement Process. It is much more difficult to live up to the underlying philosophy. Without a solid foundation, a Continuous Improvement Process can easily turn into mere superficial sloganeering, which can have the opposite effect to that desired" (1991: 78).

Conclusion

This literature review has explored the definitions of Action Workouts, quality, and Mission Capability Measurements as represented in the literature today. It has

further attempted to explain some of the theory behind the Action Workout formulation and implementation, including the different steps in the process. Finally, it has examined how quality is measured and the relationship between quality processes and profitability and production.

III. Methodology

Introduction

The objective of this research is to determine whether or not Air Force units, performing Phase and Isochronal inspection processes, have experienced a verifiable change in performance due to the implementation of the Action Workout Process. This section describes the method used to conduct the research. The units of analysis, choice of performance indicators, and data collection are covered first. A description of the statistical tests and methods used follows. Finally, the assumptions needed to draw conclusions on the data are examined and discussed.

Units of Analysis

A unit of analysis is a person or group of persons, an event, or an entity (Yin, 1989: 31). For this study, the unit of analysis is any organization employing the Action Workout Process to improve its Phase or Isochronal Inspection Program. This exploration of the effects of Action Workouts on mission capability measurements includes data from five organizations (see Table 1, page 3). First, the effects (changes in aircraft performance indicators) of the Action Workout Process on these five organizations are analyzed using piecewise linear regression. Next, using the same regression procedures, a comparative (control group) analysis is conducted using data collected from an additional eight organizations (see Table 2, page 4). Each of the

organizations under study was handled as a unit independent from the others during the data collection phase of this research.

Performance Indicators

For the purposes of this study three separate performance indicators, chosen from a very large set of logistics indicators, were combined to form a unique measure of an aircraft's ability to fulfill its mission, the "Overall RATE." This overall RATE, created by subtracting aircraft Abort and Break rates from the aircraft Mission Capable rate, accounts for three important factors describing an aircraft's ability to both fly and complete its intended mission. While any one, or several, of the many performance factors available could have been chosen, these three are effective numerical representations of a unit's ability to meet its mission requirements. When mathematically grouped together, they provide a single, easily measurable means of determining mission effectiveness.

Additionally, each performance-indicator data point represents the information accumulated over an entire calendar month and is a representative average of several data inputs (see Appendix A). The performance indicators used in this study are described in the "Air Combat Command Director of Logistics Quality Performance Measures (L-QPM) Users Guide," which describes the methods, formulae, and uses for this information. Of particular interest based on the choice of these three indicators is the following discussion:

> MC rates are an output measure based upon the greater of mission document requirements or peacetime training and support missions. Maintaining that level requires a

> maintenance investment (Total Non-Mission Capable Maintenance) and responsive supply pipeline (Total Non-Mission Capable Supply). Other characteristics such as Break, Abort, and Fix rates help determine the logistics readiness of our fleets and are also used for our standards reviews. Excerpts from our L-QPM briefings are often used by senior staff in correspondence to Air Staff and other MAJCOMs and for testimony to Congress to substantiate fleet health and requests for resources.
> (ACC, 1995:8)

Data Collection

Data collection began with an initial determination of the amount of time required to adequately quantify the results of the Action Workout Process. Data from two time periods were compared to determine if implementation of the Action Workout Process was instrumental in facilitating changes in the performance indicators discussed earlier. The periods were chosen to reflect how flying units collect, analyze, and distribute performance information in the Air Force today -- on a monthly basis. The methods used in determining each of the time periods is described below.

Each of the two time periods, while beginning and ending the same month, were not calendar-driven; rather, the time periods were based on when the Action Workout occurred at each particular base and covered a calendar year in its entirety. The first of these two time periods consisted of the 12-month period immediately preceding the arrival of the Action Workout team to the unit of analysis. For example, if the team arrived in July 1995, then data was collected for the twelve months immediately preceding this month, or July 1994 through June 1995. In the determination of the second time period, additional factors needed to be accounted for. Because the full

effects of the Action Workout were not felt by the wing until every aircraft had gone through the improved process at least once, an intervening period of twelve months of data was skipped. This intervening period allowed all aircraft in a particular unit of analysis to pass through the improved inspection process at least once. Once this intervening period of time had elapsed, the second 12-month period began. Using the previous example, the second period began in July 1996 and data was collected for the next twelve months through June 1997.

Once these initial time periods had been determined, data sources needed to be discovered and data collected. The primary source for performance data within ACC is found on the World Wide Web. The Maintenance Analysis page at the Headquarters Air Combat Command (HQACC) Combat Weapon Systems Directorate/Assessments Division site (Headquarters, 1998) contained all data required for this study (Appendix A). Each of the selected performance indicator data points represents an average value signifying an entire month's data. The data required for this study are primarily quantitative – numbers reflecting the mission capability of aircraft both before and after the Action Workout, and are consistent in language and content throughout the Air Combat Command. These data are compiled by the maintenance analysis personnel at each base and forwarded to the Maintenance Analysis Section at HQACC, where they are compiled into aircraft-type-specific databases.

Statistical Tests and Methods

After the data was gathered and organized, statistical tests and specific methodologies were examined to best determine any difference in performance factors

before and after the Action Workout. The actual data analysis was accomplished in four major sections using two computer-based statistical packages: the Windows-based Statistix program and Mathcad 7 Professional. First, the collected data was analyzed to determine its characteristics, i.e., autocorrelation. Second, regression analysis, general linear tests, and t-tests were conducted to determine whether there was a significant change in the slope or the means from before to after the Action Workout. Third, each of the data streams was examined using residual analysis techniques to ensure their trends allow for a closer fit to the regression line. Finally, trend analysis was conducted to assist in the managerial decision-making process needed to draw conclusions about the results.

Data Characteristics

Before an accurate determination could be made regarding the proper model to use in this study, it was imperative that the characteristics of the data set be determined. One measure of these characteristics is the test for autocorrelation of the dependent variables in the data set. If the dependent variables display autocorrelation tendencies, this could impact the eventual choice of model used.

Autocorrelation is defined as "the correlation between time series residuals at differing points in time" (McClave, Benson, and Sincich, 1998: 779). To ensure autocorrelation is not occurring in the data set, a correlogram is constructed and analyzed.

A major cause of autocorrelated data involving time series data is the omission of one or several key variables from the model. When this omission occurs, the error terms in the model will show a positive autocorrelation based on the effects of the missing variables (Neter, Wasserman, and Kutner, 1983: 444). Once strong evidence of

autocorrelation is established, doubt is cast on the data set and any inferences drawn from them (McClave, et al., 1998: 782); however, this does not make tests based on the data invalid.

If the time-series data consist of a small number of data points (fewer than 100), then small departures outside the parameters of the correlogram do not adversely affect the results as much as they would for a much larger number of data points (Reynolds, 1999). Should the correlogram exhibit small departures outside of the parameters, the Durbin-Watson test for autocorrelation should be conducted.

The Statistix software package displays a printout for the Durbin-Watson test for autocorrelation. This test computes both a statistic and a confidence interval to help during analysis of the autocorrelation. Essentially, if there is neither positive nor negative autocorrelation, the Durbin-Watson statistic will be close to 2. A value close to 0 suggests positive autocorrelation, and a value close to 4 suggests negative autocorrelation (Durbin and Watson, 1950: 411). Since these values are somewhat subjective, use of the observed significance level will aid in analysis. Under most circumstances, a p-value above .05 signifies that the autocorrelation is not significant enough to affect the results (Reynolds, 1999).

If evidence exists concerning significant autocorrelation, steps must be taken to correct for it. One such method for correcting this autocorrelation is use of an autoregressive model. The autoregressive model takes advantage of the autocorrelated residuals by using them to model the time series data. This combination of the preexisting regression model and the autoregression model is a very powerful tool capable of describing many aspects of the time series (McClave and Benson, 1991: 841).

Within the Statistix software package, autocorrelation plots are used to determine if autocorrelation is present. Using 95% confidence intervals, this software package enables the user to view a point-by-point printout of correlations. If the printout displays a horizontal bar outside of the parameters set for the confidence interval, then evidence of autocorrelation exists (Statistix, 1992: 254-255), and the Durbin-Watson test should be conducted.

Regression Analysis

According to Neter, et al. (1983: 30), "regression analysis serves three major purposes: (1) description, (2) control, and (3) prediction." For this study, regression analysis is essential to the quantitative description of the effects of the Action Workout Process on aircraft performance. Additionally, it improves the ability of management to control these processes and their outputs. Finally, it aids in the qualitative prediction process, helping management make decisions about the Action Workout Process in the future.

Regression analysis is a process used to determine how independent variables contribute to the eventual prediction of a dependent variable. It allows the modeler to fit data to an equation of a line, provides an estimate of the mean of the dependent variable, and predicts future values of the dependent variable based on changes in the independent variable.

Piecewise linear regression is a subset of linear regression used when the regression of the dependent variable on the independent variable follows a particular linear relation in a specific range, but follows a different linear relation elsewhere (Neter,

et al., 1983: 346). This is the case with the data streams in this study since data were collected for a 12-month period, a 12-month period was skipped, and data were again collected for a second 12-month period. This method of analysis provides a tool for comparing these separate data streams and measuring the change in slope between the two time periods. Figure 1 below displays an example of a changing slope based on two separate data streams.

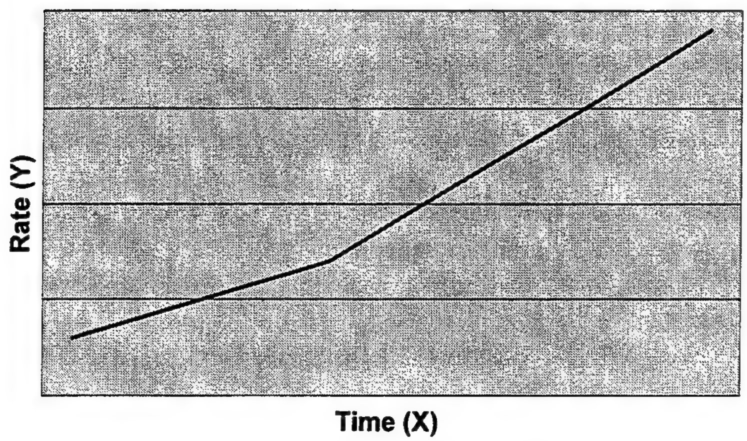


Figure 1. Piecewise Linear Regression (Change in Slope)

Furthermore, since the two sets of data are separated by a 12-month intervening time period, another indicator variable must be introduced to address the possibility of a jump in the means between these two resultant lines. Piecewise regression addresses this contingency and is an effective method for analyzing time series data when it is presented in monthly groupings (Neter, et al., 1983: 350). Figure 2 below displays an example of discontinuous piecewise regression displaying both a jump in the mean and a change in the slope created by introduction of discontinuity between the two data streams.

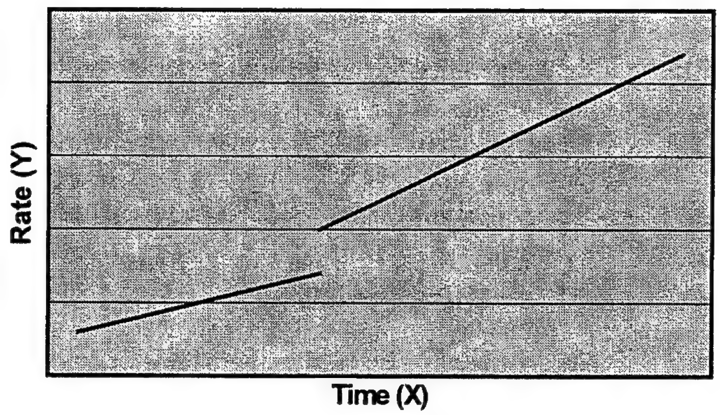


Figure 2. Piecewise Linear Regression (Change in Mean and Slope)

Approach

Following the regression analysis, I applied a systematic approach to analysis of the data. Once the units of analysis and control units had been determined and data collection was complete, correlograms were constructed to check for autocorrelation. Next, piecewise linear regression was accomplished and, at this point, based on the results, the continuing direction of the study needed to be determined.

Based on the results of the piecewise linear regression, the units were grouped into one of two types: non-stationary (Type I) or stationary (Type II). Type I units are those either exhibiting a statistically significant change in slope from the period before to the period following the Action Workout or exhibiting a similar slope for both periods with a slope departing dramatically from zero. Figure 3 below shows four possible examples of this Type I scenario, but they are not all-inclusive. There are several different ways this could be exhibited, with a difference in slopes between the two data sets as the guiding determinant.

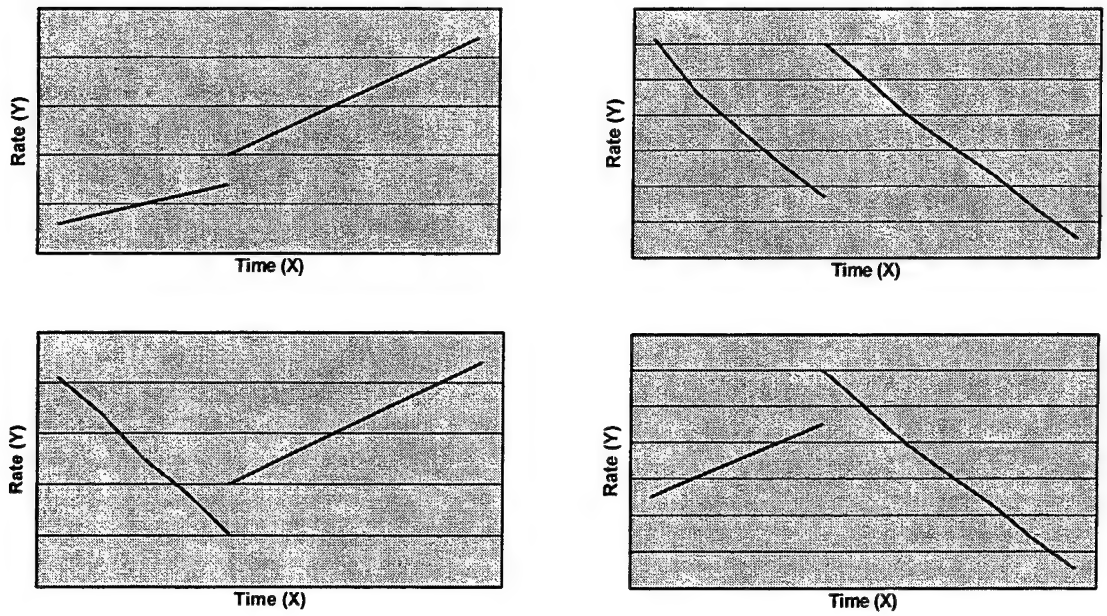


Figure 3. Examples of Type I units

Type II units, conversely, are those exhibiting stationarity. That is, the units demonstrate little or no slope and display no statistically significant difference in slope from the period before to the period following the Action Workout. Below, in Figure 4, are two examples of printouts based on data exhibiting these characteristics.

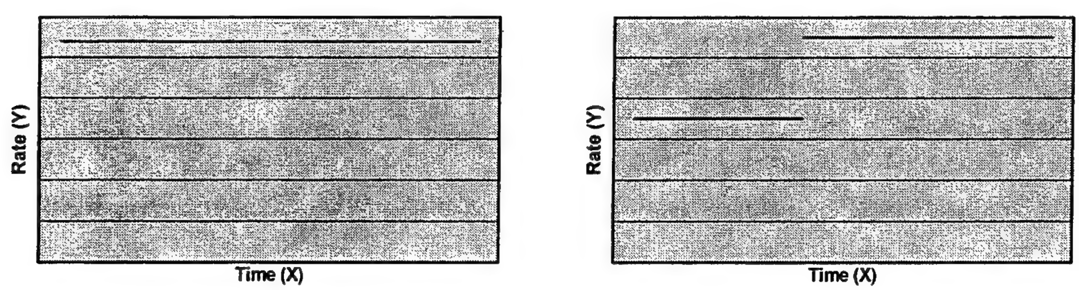


Figure 4. Examples of Type II units

Once grouped under one of these two types, the units were subjected to further analysis. If the unit was considered a Type I, then residual analysis was accomplished followed by trend analysis. If, however, the unit was a Type II unit, then normality plots were constructed and t-tests were carried out.

The Wilk-Shapiro/Rankit plot is the test for normality used in this study. A rankit plot of the variable is produced, and an approximate Wilk-Shapiro normality statistic, the Shapiro-Francia statistic, is determined (Shapiro and Francia, 1972: 215). According to Conover, Practical Nonparametric Statistics, when this statistic is at or above .916, for a sample size of 24, the assumption of normality holds true (Conover, 1980: 468).

If the assumptions needed for linear regression are met, the standardized residuals will be normally distributed with mean of 0 and variance 1. The i-th rankit is the expected value of the i-th order statistic for the sample data, assuming the sample data was from a normal distribution. The order statistics of a sample are the sample values reordered by their rank. If the sample matches a normal distribution, a plot of the rankits against the order statistics should result in a straight line, except for random variation. The Wilk-Shapiro statistic calculated is the square of the linear correlation between the rankits and the order statistics (Shapiro and Francia, 1972; 215).

Departure of the rankit plot from a linear trend indicates non-normality, as does a small value for the Wilk-Shapiro statistic. Additionally, one or a few points departing from the linear trend near the extremes of the plot are indicative of outliers. These departures should be closely examined to determine their applicability within the study (Weisberg, 1985: 159).

After analyzing the piecewise regression outputs, a determination was made regarding the use of t-tests. This determination is based on two factors: the assumed independence of the two data sets and the stationarity of the two data sets. Stationarity is established with general linear tests. These general linear tests conduct two partial F tests. The first of these two tests checks whether beta 1 is equal to zero, thus signifying stationarity of the data prior to implementation of the Action Workout. The second partial F-test is used to determine if some linear combination of beta values (in this case beta 1 and beta 2) equals some constant (in this case zero). If the answer to these questions is yes, then this small-sample test of hypothesis about a population mean is required and a calculated value of t is computed.

The Wilk-Shapiro test for normality and the t-tests may seem redundant given the power and ability of piecewise linear regression to present this information. These tests, however, provide a clearer representation of the change in the mean of units exhibiting stationarity (Reynolds, 1999).

After running the test for normality and the t-tests, residual anlysis and trend analysis were again conducted on these Type II units. This analysis is similar to that conducted on the Type I units, but is no less important given the necessity to draw conclusions about the change in the overall RATE and its cause.

Residual Analysis

Once the regression model and necessary t-tests were complete, residual analysis was performed on both the Type I and Type II units. Residual analysis is a very important part of regression, and should not be overlooked. Residuals are used to

evaluate how well the model fits the data. Neter defines a residual as "the difference between the observed value…and the corresponding fitted value" (Neter, et al., 1983: 43). The analysis of these differences is a very powerful tool for the modeler and helps in the final determination of the aptness of the model.

Essentially, residual analysis is used to examine six types of departures from the model. The first type is nonlinearity of the regression function and is usually examined by analyzing a scatter plot of the data; a steeply sloped line, however, is difficult to analyze with a scatter plot and requires use of a plot of the residuals. The second type of departure is nonconstancy of error variance (heteroscedasticity). By plotting the residuals against the independent variable, the modeler can determine whether the variance of the error terms is constant. Discovering the presence of outliers, or extreme observations, is the third type of departure. Learning of the existence of these outliers allows the modeler to make decisions concerning misleading fit. The fourth type of departure is nonindependence of error terms. This check is used to determine whether there is correlation of the error terms over a given timeframe or a lack of randomness in the data. Nonnormality of the error terms is the fifth type of departure. When the model was built, residuals were assumed to be normally distributed with a mean of zero. If after this analysis this assumption proves to be untrue, the dependent variables may need to be transformed to ensure the data more closely fits the regression line. The sixth type of departure is an incomplete model. The residuals should be plotted against any independent variables omitted from the model. This checks these additional independent variables to determine if they can provide important additional descriptive or predictive power to the model (Neter, et al., 1983: 111-122).

Once the data have been tested for autocorrelation, piecewise linear regression and appropriate t-tests have been accomplished, and residual analysis is complete, qualitative analysis of the data must be done. This qualitative analysis is achieved through managerial trend analysis.

Trend Analysis

Was there a statistically significant difference in aircraft performance after the implementation of the Action Workout Process compared to performance before implementation? This is the question trend analysis attempts to address.

Using the outputs of the piecewise linear regression models, the modeler looks for statistically significant (α=.05) differences in the slope and means of the data. This quantitative comparison between data collected before the Action Workout and after the Action Workout allows the modeler to draw conclusions at a particular level of confidence within calculated confidence intervals. The conclusions derived from data of this nature are very powerful and can be used with confidence in managerial decisionmaking because of their foundation in the science of statistical mathematics.

Conversely, what if the change brought about by the implementation of this process was determined not to be statistically significant? In this case, a qualitative trend analysis would need to be conducted. The modeler must analyze the trend over the first time period and the second time period and draw conclusions based on the direction and amount of movement in the line of regression. Additionally, the modeler must compare the trends at the units of analysis with the trends over the same time periods at the control groups used in the study.

Following this roadmap, both quantitative and qualitative criteria were considered during the trend analysis. Trend analysis is a far more flexible method of drawing conclusions and allows for creativity on the part of management when it comes to making decisions based on data contained within the study (Reynolds, 1999).

Assumptions

For this research I assumed that performance data found on the Maintenance Analysis page at the Headquarters Air Combat Command Combat (HQACC) Weapon Systems Directorate/Assessments Division site (Headquarters, 1998) was accurate and complete. Additionally, I assumed that the data collected at this site was an accurate representation of actual maintenance performance measures. Finally, this study was limited to the effects of the Action Workout Process on ACC bases implementing it within their phase or isochronal inspection sections.

From a data collection and analysis standpoint, an additional assumption was required. Although the two data streams were related and, in some instances, exhibited autocorrelation, an assumption of independence was necessary for the application of the piecewise linear regression methodology.

Summary

This chapter has detailed the methods used to conduct the research effort. The units of analysis, choice of performance indicators, and data collection was covered first. This was followed by a description of the statistical tests and methods used. Finally, the assumptions needed to draw conclusions on the data were examined and discussed.

IV. Results and Analysis

Introduction

This study addressed the basic question: "what is the impact of the Action Workout Process on aircraft mission-capability measures?" Specifically, was there a noticeable, statistically verifiable, positive or negative change in the mission capability of aircraft assigned to the units implementing the Action Workout Process in their aircraft inspection sections? To effectively determine if there was a definitive change in the mission capability of assigned aircraft, three questions were addressed:

1. Can the effects of the Action Workout be quantified and measured?
2. Was the Action Workout an effective means of improving aircraft performance?
3. What issues affected the relationship between the Action Workout Process and changes in the mission capability of aircraft?

This chapter, using the data collected, addressed the first two of these three questions through a comprehensive quantitative and qualitative analysis of data from the five units of analysis and the eight control units. These findings were examined initially individually for autocorrelation. Then the units were grouped by aircraft type to allow for a more thorough comparative analysis. Once grouped, regression analysis was conducted to determine whether there was a significant change in the slope or the means from before to after the Action Workout. Additionally, general linear tests were used to determine whether the units were Type I or Type II. If found to be Type II, the Wilk-

Shapiro test for normality and two-sample t-tests were conducted. Next, residual analysis was done to ensure the data trends allowed for a closer fit to the regression line. Finally, trend analysis was conducted to assist in the managerial decision-making process, which is an integral part of the next chapter, needed to draw conclusions about the results.

Autocorrelation

As described earlier, the test for autocorrelation is essential to any time-series analysis. Correlograms for this study ensured there was no autocorrelation between time series residuals at differing points in time. Where the correlograms displayed evidence of autocorrelation, Durbin-Watson tests ensured the level of autocorrelation was not significant.

Autocorrelation of the dependent variable RATE was tested for using a correlogram. These plots are contained in Appendix B. Any points occurring outside the parameters of the correlogram indicated the possibility of autocorrelation. Table 7 lists each of the bases under study and whether autocorrelation was possible based on the results of the correlogram.

Table 7. Correlogram Results
(Highlighted units conducted Action Workouts)

Unit	Base	Aircraft	Autocorrelation?
366 WG	Mt Home	F-15C/D	No
1 FW	Langley	F-15C/D	Yes (Lag 1)
33 FW	Eglin	F-15C/D	Yes (Lag 1)
57 WG	Nellis	F-15C/D	Yes (Lag 1)
55 WG	Offutt	RC-135	No
57 WG/66 RQS	Nellis	HH-60	No
347 FW	Moody	HH-60	No
49 FW	Holloman	HH-60	Yes (Lag 1)
552 ACW	Tinker	E-3	Yes (Lag 1)
355 FW (Ops)	Davis-Montham	A-10	Yes (Lag 1)
23 WG	Pope	A-10	Yes (Lag 1)
57 WG	Nellis	A-10	Yes (Lag 1)
347 WG	Moody	A-10	Yes (Lag 1)

When the correlograms identified bases exhibiting autocorrelation, the Durbin-Watson test was required to determine the level and significance of the autocorrelation. Table 8 lists the results of the Durbin-Watson test. A test statistic of approximately 2 indicates the residuals are uncorrelated, a test statistic of approximately 0 indicates strong positive autocorrelation, and a test statistic of approximately 4 indicates strong negative autocorrelation. In this study, most of the Durbin-Watson test statistic results are

approximately 2, signifying autocorrelation of little significance in terms of its effect on the analysis of the data (McClave and Benson, 1991: 826).

Table 8. Durbin-Watson Test Results
(Highlighted units conducted Action Workouts)

Unit	Base	Aircraft	Test Statistic
366 WG	Mt Home	F-15C/D	N/A
1 FW	Langley	F-15C/D	1.1264
33 FW	Eglin	F-15C/D	1.7083
57 WG	Nellis	F-15C/D	1.7722
55 WG	Offutt	RC-135	N/A
57 WG/66 RQS	Nellis	HH-60	N/A
347 FW	Moody	HH-60	N/A
49 FW	Holloman	HH-60	1.7011
552 ACW	Tinker	E-3	1.3247
355 FW (Ops)	Davis-Montham	A-10	1.9472
23 WG	Pope	A-10	.9268
57 WG	Nellis	A-10	1.9357
347 WG	Moody	A-10	2.1509

Where the test statistic approaches 1, more observations are required. As Neter states, however, “with time series data it may be impossible to obtain more observations, or additional observations may lie in the future and be obtainable only with great delay”

(Neter, et al., 1983: 454). This was the case with this study. The relatively new application of the Action Workout Process within the Air Force has limited the amount of data available after the improvement process is implemented. Therefore, no more than a rough estimate of autocorrelation can be determined since it is impossible to approach the approximately 40 degrees of freedom required for definitive proof that autocorrelation exists (Neter, et al., 1983: 454).

Regression Analysis, T-Tests, Residual Analysis, and Trend Analysis

As stated earlier, "regression analysis serves three major purposes: (1) description, (2) control, and (3) prediction" (Neter, et al., 1983: 30). For this study, regression analysis was essential to the quantitative and qualitative description of the effects of the Action Workout Process on aircraft performance. It provided both a statistical and a visual means of interpreting and comparing the data from both before and after implementation of the Action Workout.

For both the units of analysis and the control units, the dependent variable, RATE, was regressed against the independent variables time (Mo), before versus after the Action Workout slope (X1), and before versus after the Action Workout discontinuity (X2). If there was a significant discontinuity ($\alpha \leq .05$) in the data streams, then all of the independent variables remained in the model; otherwise, independent variables were removed until the required alpha-level was attained and an appropriate model was fit.

After analysis of the piecewise regression outputs, the unit was determined to be Type I or Type II. For the Type II unit, t-tests were used. This t-test determination was based on two factors: the assumed independence of the two data sets and the stationarity,

established with the general linear test, of the two data sets. For this study, stationarity was ascertained through analysis of the beta coefficients. If beta 1 (Mo) and beta 2 (X1) were both approximately zero based on the partial F tests, then the slope of their estimated lines was approximately zero and they were therefore stationary. Taken together, these two stationary estimated lines make the unit Type II and create the opportunity to use the two-sample t-test. If it was determined that this small-sample test of hypothesis about a population mean, based on the partial F tests, was required, a calculated value of t was computed. This value was then used to draw conclusions about the change in the RATE and its cause.

Once the regression model, general linear tests, and necessary t-tests were complete, residual analysis was performed. This is a very important part of regression, and should not be overlooked. Residuals are used to evaluate how well the model fits the data. For this study, standardized residual plots were examined to determine if second-order terms were needed or outliers existed that skewed the data. The analysis of these residuals was a very powerful tool for the modeler and helped in the final determination of the aptness of the model.

During residual analysis, the equality of error variances was analyzed to ensure the homoscedasticity of the data sets. Using a two-sample t-test of the residuals, the variances from the first time period were compared to the variances for the second time period. Equality of these variances ensured the data sets were homoscedastic.

Finally, after residual analysis, a qualitative trend analysis was conducted. This was needed to analyze the trend over the first time period and the second time period and draw conclusions based on the direction and amount of movement in the line of

regression. Additionally, the trend at the unit of analysis was compared with the trend over the same time period at the control groups used in the study.

For simplicity, this section is broken into five subsections. Each of the subsections comprises an examination of each of the five units of analysis, to include an assessment of the control groups applicable to that particular unit of analysis. First, within each subsection, the results of the piecewise linear regressions conducted on the experimental and control groups and any normality and t-tests needed to clarify the results are discussed. Next, residual analysis is conducted to ensure the data trends allow for a closer fit to the regression line. Finally, trend analysis is conducted to assist in the managerial decision-making process needed to draw conclusions about the results.

366 WG, Mountain Home AFB

The Action Workout at Mountain Home AFB took place during the week of 25-29 March, 1996. Following initial training, the 366 WG F-15C phase personnel were formed into five teams which analyzed various portions of both the inspection process itself and the local manufacture and resources practices. By the end of the week each team had produced several improvements. The teams had reduced the cycle time of many processes (by as much as 88%) and the distances traveled (by as much as 97%) to complete inspection requirements, while reducing the overall phase inspection cycle time from 7.1 days to 5.4 days (24% improvement) (Trip Report-366, 1998).

Piecewise Linear Regression. Piecewise regression analysis was conducted on the data collected for Mountain Home AFB (see Appendix C) and the best fit included all

three of the independent variables within the model. Plotting the estimated points resulted in the graph contained in Figure 5 below.

NOTE: In each of the piecewise linear regression figures below, months 1-12 represent the 12-month period prior to the arrival of the Action Workout team and months 13-24 represent the 12-month period following passage of all aircraft through the improved inspection process. The reader should understand there is another 12-month period between these two during which aircraft from the particular unit passed through the inspection process.

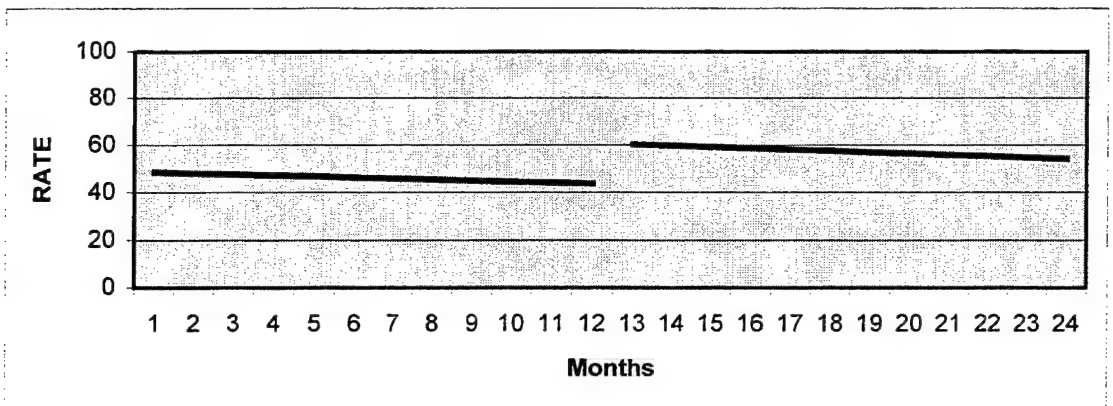


Figure 5. Piecewise Linear Regression
(F-15, Mountain Home AFB)

The figure and the p-value associated with the X2 variable (.0141) clearly indicate that the jump exhibited at the end of the first 12-month period was statistically significant. This jump represented a 17.2507 increase in the RATE over that estimated at the end of the first 12-month period. While this appears to be significant when taken

alone, additional conclusions require comparison to the F-15 control groups to determine trends.

Additionally, analysis of the general linear test results demonstrates that the slopes do not differ noticeably from the first to the second 12-month time period. These results will also require further analysis to verify whether these comparable slopes were nevertheless significant when compared to the F-15 control groups.

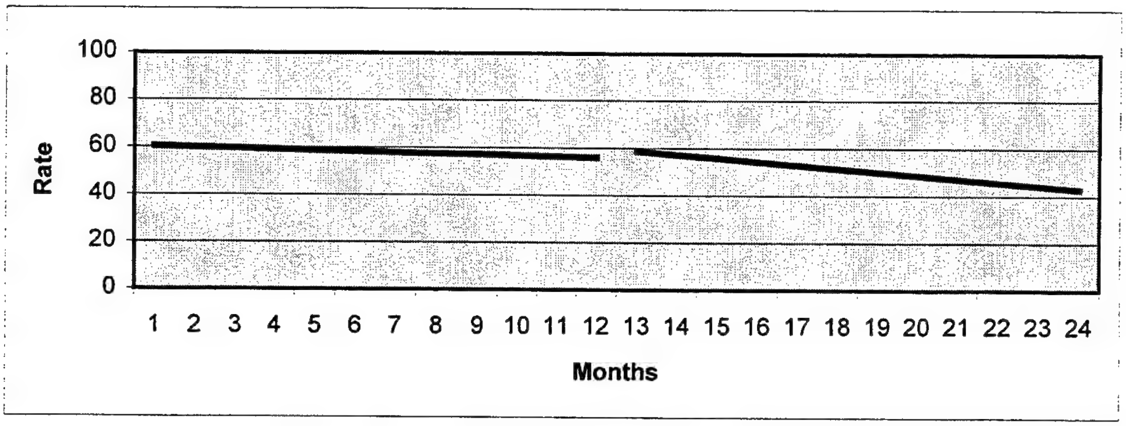


Figure 6. Piecewise Linear Regression
(F-15, Langley AFB)

The F-15 control groups were the 1 FW at Langley AFB, the 33 FW at Eglin AFB, and the 57 WG at Nellis AFB. Among these, Eglin (Figure 7) was the only control group to exhibit a significant jump in the X2 variable. It had a p-value of .0020 and exhibited an estimated jump in the RATE of 11.3674. Langley (Figure 6) and Nellis (Figure 8) did not show significant jumps or p-values (4.12890, .4367 and .95874, .8885 respectively), and because of this their final models did not contain the X2 variable.

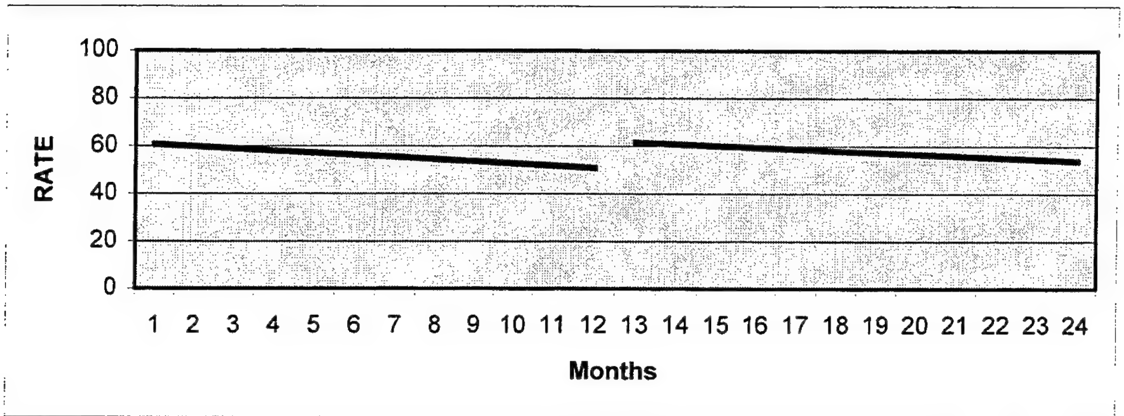


Figure 7. Piecewise Linear Regression
(F-15, Eglin AFB)

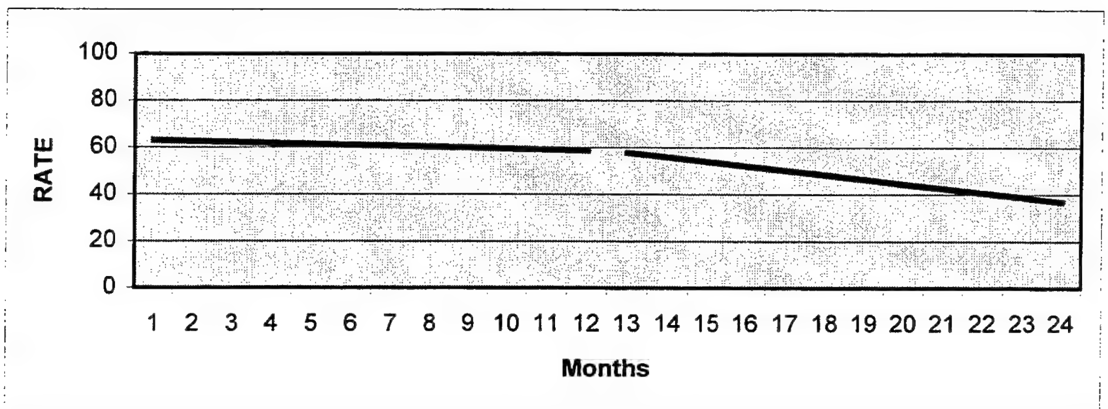


Figure 8. Piecewise Linear Regression
(F-15, Nellis AFB)

Analysis of the outputs from the general linear tests for each of the three control units indicated the change in slope from the first to the second 12-month period was significant for each of the three control units. For each of the units, at least one of the two formulated F-statistics were above the predetermined .05 alpha level computed F-

statistic. Because of this lack of stationarity of the control units, t-tests could not be used to assist in the final analysis of these unit's data.

Table 9. General Linear Test Results (F-15)
(Highlighted unit conducted Action Workout)

Unit	Base	F-Statistic Prior to AWO	F-Statistic After AWO	Computed F-Statistic	Stationary?
366 WG	Mt Home	0.453	0.74	4.351	Yes
1 FW	Langley	0.535	7.295	4.351	No
33 FW	Eglin	7.544	4.677	4.351	No
57 WG	Nellis	0.308	7.662	4.351	No

Two-Sample T-Tests. Following the piecewise linear regression on each of the four F-15 units, a two-sample t-test was accomplished on the data set exhibiting stationarity to determine if there was a statistically significant change in the mean of the RATE from before to after Action Workout implementation. Also available from this test was a determination of the direction of this change, if any. Based on the necessity for stationarity in the two data sets, the unit of analysis, Mountain Home, was the only unit deemed Type II and analyzed using the two-sample t-test.

The tests for normality were used to determine if it was appropriate to use t-tests or if non-parametric tests were needed. Table 10 summarizes the results of the Wilk-Shapiro test. Rankit plots are available in Appendix D. For the data sets used in this study, the table value for the Wilk-Shapiro statistic at $\alpha = .05$ was .916. For a sample

size of 24, any values above this table value were considered to be from a normal distribution (Conover, 1980: 468).

Table 10. Wilk-Shapiro Test for Normality Results (F-15)
(Highlighted unit conducted Action Workout)

Unit	Base	Aircraft	Statistic	Normal?
366 WG	Mt Home	F-15C/D	.9337	Yes

These test results clearly show a significant increase in the mean of the RATE at Mountain Home. The printout for this two-sample t-test can be found in Appendix E, while a brief synopsis of the results is in Table 11 below.

Table 11. Two-Sample T-Test Results (F-15)
(Highlighted unit conducted Action Workout)

Unit	Base	Before AWO Mean RATE	After AWO Mean RATE	Delta	Equal Variance	P-Value
366 WG	Mt Home	46.175	57.350	11.175	Yes	.0017

Residual Analysis. For this study, standardized residual plots were examined (Appendix F) to determine if second-order terms were needed or outliers existed that skewed the data. The residual plots demonstrated that the residuals were relatively linear and did not require the introduction of second-order terms. The analysis of these

residuals verified the homoscedasticity of the data and the aptness of the models used in this study.

Trend Analysis. To determine the underlying trends displayed by piecewise linear regression and two-sample t-tests they need to be examined beyond the numbers they contain.

The trends contained in the data from Mountain Home AFB were easily discernible. The regression analysis and t-test results (11.175 increase) clearly showed an improvement in the RATE from the period before the Action Workout to the period after the Action Workout. This was in direct contrast to the results from the three F-15 control units, where the results were not nearly as dramatic. At Eglin, while there was a statistically significant jump from the end of the first to the beginning of the second period, the overall trend changed very little and appeared to follow a cyclical pattern. At Langley, there was almost no jump and relatively little change in the slope of the line of regression. Finally, at Nellis, again there was almost no jump, and while the slope changed somewhat, it was not significant.

Examined as a whole, the trends for the four F-15 bases were quite telling. It was evident that the unit of analysis, Mountain Home AFB, showed improvement after implementation of the Action Workout Process. This, however, could be attributed to many different variables if examined on its own, but when compared to the F-15 control units, it was remarkable. Assuming each of these F-15 units operate under similar constraints, the fact that Mountain Home improved its RATE dramatically while the three control units RATE remained unchanged or deteriorated was significant.

55 WG, Offutt AFB

The Action Workout at Offutt AFB took place during the week of 29 July – 2 August, 1996. After the Action Workout team initially conferred with the maintenance personnel involved, the 55 WG RC-135 isochronal personnel were again formed into five teams which analyzed various portions of both the inspection process itself and the overall logistics of the inspection process. At the end of the week, although the Action Workout team was faced with the challenges inherent with 13 different models of the aircraft assigned, dramatic improvements were realized. The teams had reduced the cycle time of many processes (by as much as 95%) and the distances traveled (by as much as 95%) to complete inspection requirements, while reducing the overall phase inspection cycle time from just under 8 days to just over 6 days (Trip Report-55, 1998).

Piecewise Linear Regression. The unique nature of the RC-135 does not allow for control groups. Therefore, examination of the data and the conclusions drawn during the analysis were stand-alone and without comparison.

Piecewise regression analysis was conducted on the data collected for Offutt AFB (see Appendix C) and none of the independent variables were significant enough to be left in the model. Plotting the estimated points resulted in the graph contained in Figure 9 below. It was clear from the chart and from the p-values associated with the independent variable X2 (.6288) that there was no statistically significant change in terms of RATE jump from the end of the first 12-month period to the start of the second 12-month period.

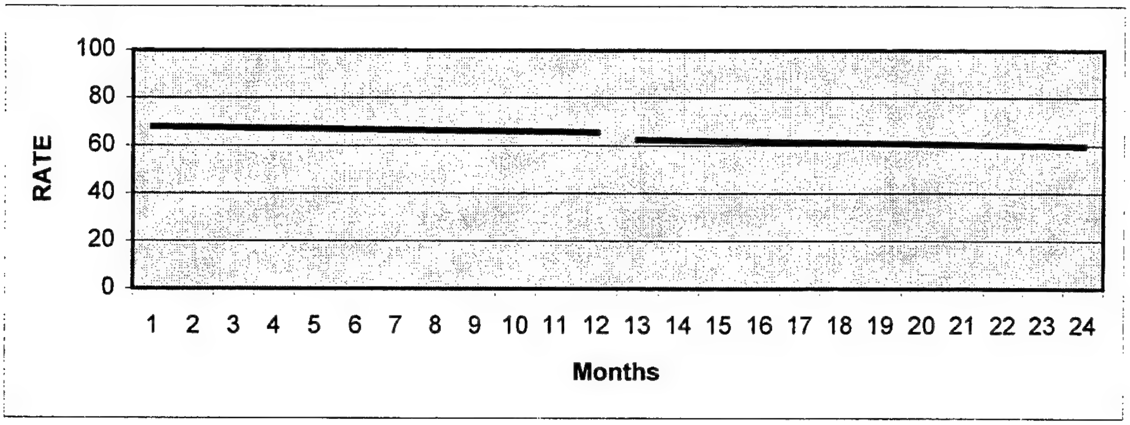


Figure 9. Piecewise Linear Regression
(RC-135, Offutt AFB)

Two-Sample T-Test. The output from the general linear test clearly showed that the slopes for the first and second 12-month period were approximately zero for this unit of analysis. The formulated F-statistics for each time period fall below the predetermined .05 alpha level computed F-statistic, therefore this was considered a Type II unit and t-tests were conducted.

Table 12. General Linear Test Results (RC-135)
(Highlighted unit conducted Action Workout)

Unit	Base	F-Statistic Prior to AWO	F-Statistic After AWO	Computed F-Statistic	Stationary?
55 WG	Offutt	0.119	0.166	4.351	Yes

Since this was a Type II unit, a test for normality and a two-sample t-test was accomplished to ensure there was not a statistically significant change in the mean of the

RATE from before to after Action Workout implementation. Based on the p-value obtained (.0620), the change in RATE from the first time period to the second time period was not significantly different. The printouts for the normality test and the two-sample t-test can be found in Appendices D and E, respectively, while a brief synopsis of the results are in Table 13 and 14 below.

Table 13. Wilk-Shapiro Test for Normality Results (RC-135)
(Highlighted unit conducted Action Workout)

Unit	Base	Aircraft	Statistic	Normal?
55 WG	Offutt	RC-135	.9301	Yes

Table 14. Two-Sample T-Test Results (RC-135)
(Highlighted unit conducted Action Workout)

Unit	Base	Before AWO Mean RATE	After AWO Mean RATE	Delta	Equal Variance	P-Value
55 WG	Offutt	66.792	61.150	-5.6417	No	.0620

Residual Analysis. As stated earlier in this chapter, standardized residual plots were examined (Appendix F) to determine if second-order terms were needed or outliers existed that skewed the data. The residual plots demonstrated that the residuals were relatively linear and did not require the introduction of second-order terms. The analysis of these residuals verified the homoscedasticity of the data and the aptness of the models used in this study.

Trend Analysis. Due to the unique aircraft employed at Offutt AFB, control groups were unavailable for this portion of the study. The piecewise linear regression and two-sample t-test provided a plethora of useful information. Contrary to the F-15 units, however, the trends contained in the data from Offutt AFB were not so easily discernible. The regression analysis (no noticeable movement), general linear test (stationarity), and t-test results (5.6417 decrease) were not quite as clear in their representation of a change in the RATE for the period from before the Action Workout to the period after the Action Workout.

Overall, the trend for the RC-135 base was really no trend at all. The data from the unit of analysis, Offutt AFB, showed no statistically significant changes from before the Action Workout to after the Action Workout. This lack of change, coupled with the fact there were no control units for this unit of analysis, made further analysis difficult.

57 WG, Nellis AFB

The Action Workout at Nellis AFB took place during the week of 12-16 August, 1996. Responding to a request from the 57 WG, the AWO team arrived at Nellis AFB to assist in improving the wing's HH-60 phase inspection process. Working under the guidelines of reducing waste and streamlining the inspection process to meet increased workloads in the coming year, the team began the improvement process. Following initial training, the 57 WG HH-60 phase personnel were formed into five teams which analyzed various portions of both the inspection process and support system. By the end of the week each team had produced several improvements. The teams had reduced the cycle time of many processes (by as much as 80%) and the distances traveled (by as

much as 90%) to complete inspection requirements, while reducing the overall phase inspection cycle time from 21 days to just under 18 days (14% improvement) (Trip Report-57, 1998).

Piecewise Linear Regression. Piecewise regression analysis was conducted on the data collected for Nellis AFB (see Appendix C) and the best fit did not include any of the three independent variables. This signified that no change occurred from the first to the second time period. Plotting the estimated points resulted in the graph contained in Figure 10 below.

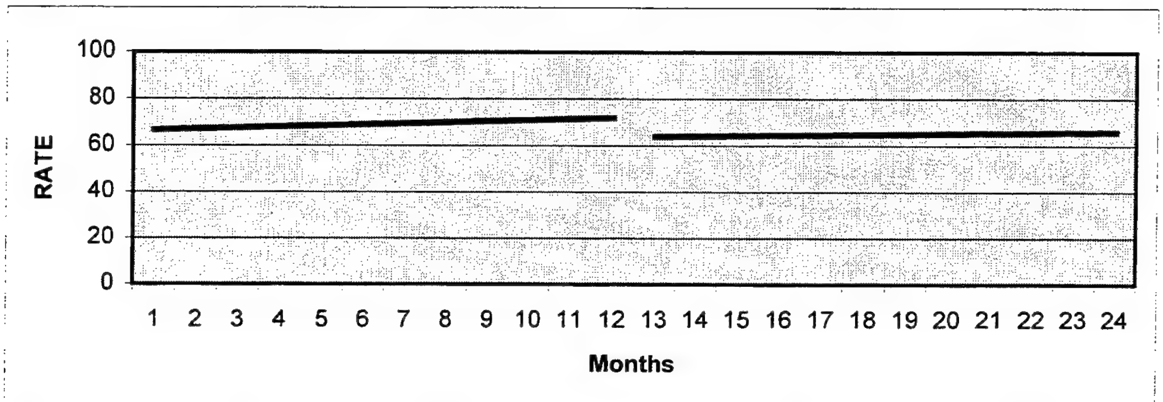


Figure 10. Piecewise Linear Regression
(HH-60, Nellis AFB)

The figure and the p-value associated with the independent variable X2 (.2168) clearly indicate that there was no statistically significant change, in terms of RATE jump, from the first 12-month period to the second 12-month period at Nellis AFB. With this unit of analysis, however, further analysis will require comparison to the HH-60 control groups to determine trends.

Also, using the general linear tests, it was clear that the slopes were not noticeably different from the first to the second 12-month time period for this unit of analysis. This unit of analysis also required further investigation to verify whether these comparable slopes were nevertheless significant when compared to the HH-60 control groups.

The HH-60 control groups were the 347 FW at Moody AFB and the 49 FW at Hollomon AFB. At both of these bases significant movement was exhibited with the piecewise linear regression and, as a result, all three independent variables were included in the final models. At Moody (Figure 11), a significant decrease in the X2 variable was seen as a result of the regression analysis. It had a p-value of .0454 and exhibited an estimated decrease in the RATE of 15.7681. The Hollomon model (Figure 12) exhibited similar results to those seen at Moody, a significant decrease in the X2 variable. It displayed a p-value of .0009 and exhibited an estimated decrease in the RATE of 33.0786.

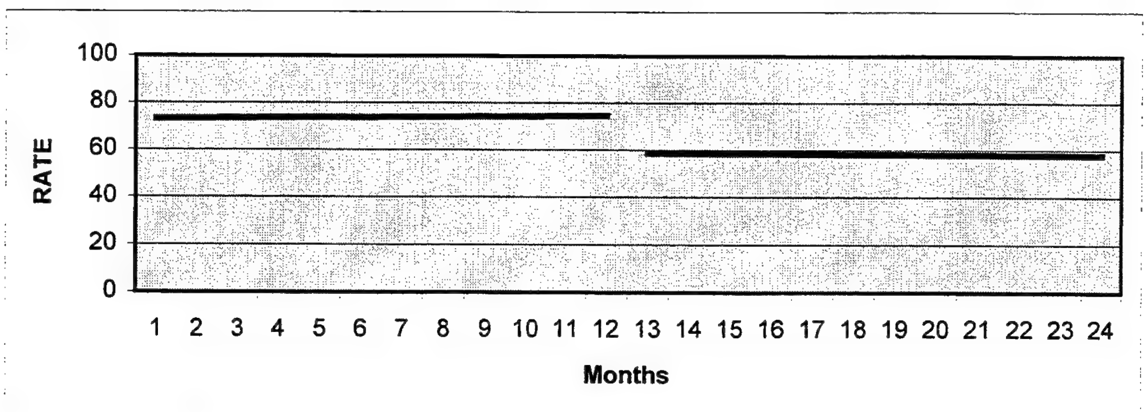


Figure 11. Piecewise Linear Regression
(HH-60, Moody AFB)

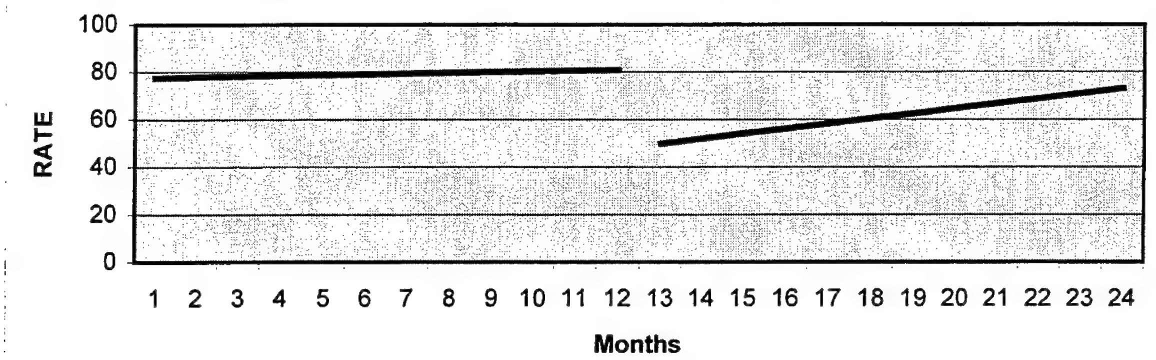


Figure 12. Piecewise Linear Regression
(HH-60, Hollomon AFB)

Analysis of the outputs from the general linear tests for each of the control units indicated the change in slope from the first to the second 12-month period was significant for only Hollomon. Here, one of the formulated F-statistics was above the .05 alpha level computed F-statistic. Because of this lack of stationarity of the Hollomon data, a t-test could not be used to assist in the final analysis of this unit's data; however, this was not the case with Nellis, where the formulated F-statistics did allow for the use of the t-test.

Table 15. General Linear Test Results (HH-60)
(Highlighted unit conducted Action Workout)

Unit	Base	F-Statistic Prior to AWO	F-Statistic After AWO	Computed F-Statistic	Stationary?
57 WG	Nellis	0.537	0.083	4.351	Yes
347 FW	Moody	0.026	0.01	4.351	Yes
49 FW	Hollomon	0.339	5.592	4.351	No

Two-Sample T-Tests. Following the piecewise linear regression and general linear tests on each of the three HH-60 units, two-sample t-tests were accomplished on the data sets exhibiting stationarity to determine if there was a statistically significant change in the mean of the RATE from before to after Action Workout implementation. Also available from this test was a determination of the direction of this change, if any.

Stationarity in two of the three data sets was exhibited when examining the beta 1 and beta 2 coefficient results from the general linear test. Because of this, Nellis and Moody were considered Type II and two-sample t-tests were in order. After running the Wilk-Shapiro test for normality and the t-tests, there was not a statistically significant change in the mean RATE at Nellis AFB, but it was evident there was a statistically significant decrease in the mean RATE at Moody. The printouts for these normality tests and two-sample t-tests can be found in Appendices D and E, respectively, while a brief synopsis of the results are in Tables 16 and 17 below.

Table 16. Wilk-Shapiro Test for Normality Results (HH-60)
(Highlighted unit conducted Action Workout)

Unit	Base	Aircraft	Statistic	Normal?
57 WG/66 RQS	Nellis	HH-60	.9903	Yes
347 FW	Moody	HH-60	.9735	Yes

Table 17. Two-Sample T-Test Results (HH-60)
(Highlighted unit conducted Action Workout)

Unit	Base	Before AWO Mean RATE	After AWO Mean RATE	Delta	Equal Variance	P-Value
366 WG	Nellis	69.367	65.025	-4.3417	Yes	.1752
347 FW	Moody	73.842	58.250	-15.592	Yes	.0002

Residual Analysis. The standardized residual plots for this study were examined (Appendix F) to determine if second-order terms were needed or outliers existed that skewed the data. The residual plots demonstrate the residuals were relatively linear and did not require the introduction of second-order terms. The analysis of these residuals verified the homoscedasticity of the data and the aptness of the models used in this study.

Trend Analysis. The trends observed in the data from Nellis AFB, Moody AFB, and Hollomon AFB all point toward a drop-off, of varying degrees, from the first to the second time period. The regression analysis and t-test results clearly show decreases in the RATE, but amount was more telling than the direction. At Nellis, while there was a statistically significant drop from the end of the first to the beginning of the second period (-33.0786), the overall mean RATE change was not statistically significant (-4.3417). Similarly, at Moody and Hollomon, there were also statistically significant drops from the end of the first to the beginning of the second period (-15.7681 and –33.0786, respectively), but contrary to Nellis, the change in mean RATE at Moody was statistically significant (15.592 decrease).

Examined alone, the data seemed to indicate a decrease in the RATE at each of the three units, but a closer look revealed additional information. While it was true the

RATE had decreased at each unit, there was a marked difference in the amount of decrease at the unit of analysis versus the control units. It was evident that the unit of analysis, Nellis AFB, showed a much smaller decrease in mean RATE after implementation of the Action Workout Process. The decreases across the HH-60 fleet could be attributed to many different variables, but assuming each of these units operate under similar constraints, the fact that Nellis decreased its RATE much less than the two control units during the same time period was significant.

552 ACW, Tinker AFB

The Action Workout at Tinker AFB took place during the week of 4–8 November, 1996. After initially conferring with the maintenance personnel involved, the 552 ACW E-3 isochronal personnel were once again formed into five teams which analyzed various portions of the inspection process. At the end of the week, although each team had to improve upon a process that was recently altered, dramatic improvements were realized. The teams had reduced the cycle time of many processes (by as much as 8 hours for some tasks) and the distances traveled (by as much as 12,000 feet for some tasks) to complete inspection requirements. They had accomplished this while simultaneously reducing the overall phase inspection cycle time from 4.2 days to 3.2 days (Trip Report-552, 1998).

Piecewise Linear Regression. The unique nature of the E-3 does not allow for control groups. Therefore, examination of the data and the conclusions drawn during the analysis of the data were without comparison.

Piecewise regression analysis (see Appendix C) was conducted on the data collected for Tinker AFB and the drop-off in RATE between time period one and time period two was not significant enough to be left in the model. The slope of the estimated lines, however, based on the general linear tests, was determined to be approximately zero. Plotting the estimated points resulted in the graph contained in Figure 13 below.

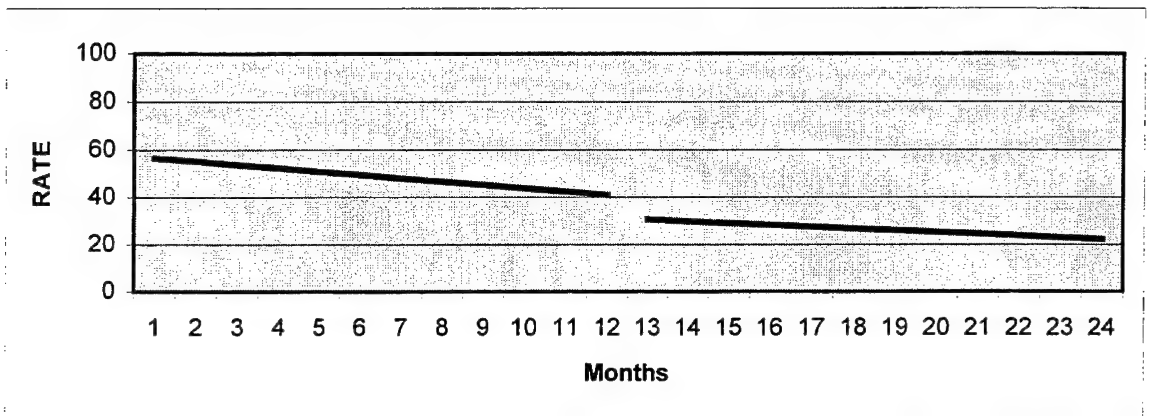


Figure 13. Piecewise Linear Regression
(E-3, Tinker AFB)

Two-Sample T-Test. A two-sample t-test was accomplished for this data set even though the general linear test output represented this unit as Type I. Although one of the formulated F-statistics was slightly above the predetermined computed .05 alpha level F-statistic, it was close enough to the required value to warrant running of the t-test.

Table 18. General Linear Test Results (E-3)
(Highlighted unit conducted Action Workout)

Unit	Base	F-Statistic Prior to AWO	F-Statistic After AWO	Computed F-Statistic	Stationary?
552 ACW	Tinker	4.496	1.299	4.351	No

As mentioned earlier, although this was a Type I unit, a test for normality and a two-sample t-test were accomplished to determine if there was a statistically significant change in the mean of the RATE from before to after Action Workout implementation. Based on the p-value obtained (.0000), the change in RATE from the first period to the second time period was significantly different. The printouts for the normality test and the two-sample t-test can be found in Appendices D and E, respectively, while a brief synopsis of the results are in Tables 19 and 20 below.

Table 19. Wilk-Shapiro Test for Normality Results (E-3)
(Highlighted unit conducted Action Workout)

Unit	Base	Aircraft	Statistic	Normal?
552 ACW	Tinker	E-3	.9566	Yes

Table 20. Two-Sample T-Test Results (E-3)
(Highlighted unit conducted Action Workout)

Unit	Base	Before AWO Mean RATE	After AWO Mean RATE	Delta	Equal Variance	P-Value
552 ACW	Tinker	48.883	26.500	-22.383	Yes	.0000

Residual Analysis. The residual plots for this data indicate that the residuals were relatively linear and did not require the introduction of second-order terms. The analysis of these residuals verified the homoscedasticity of the data and the aptness of the models used in this study.

Trend Analysis. Once again, due to the unique aircraft employed in the 552 ACW at Tinker AFB, control groups were unavailable for this portion of the study. The piecewise linear regression analysis and general linear tests indicate the process at Tinker changed significantly from before to after the visit of the Action Workout team. Additionally, just as was the case with the Offutt data, the trend for Tinker was really no trend at all. While the data from the unit of analysis showed statistically significant changes from before the Action Workout to after the Action Workout, the fact there were no control units for this unit of analysis, once again, made it difficult to examine further trends.

355 FW, Davis-Montham AFB

The Action Workout at Davis-Montham AFB took place during the week of 19-23 May, 1997. Just as they had done in each of the earlier Action Workout team visits, the 355 FW A-10 phase personnel were formed into five teams which analyzed various

portions of the inspection process. After completion of the visit, each team had produced several improvements. The teams had reduced the cycle time of many processes (by as much as 82%) and the distances traveled (by as much as 87%) to complete inspection requirements, while reducing the overall phase inspection cycle time from 75 hours to 48 hours (36% improvement) (Trip Report-355, 1998).

Piecewise Linear Regression. Piecewise regression analysis was conducted on the data collected for Davis-Montham AFB (see Appendix C) and the final model did not include the X2 independent variable because there was not a statistically significant jump from the end of the first data stream to the beginning of the second data stream. Plotting the estimated points resulted in the graph contained in Figure 14 below.

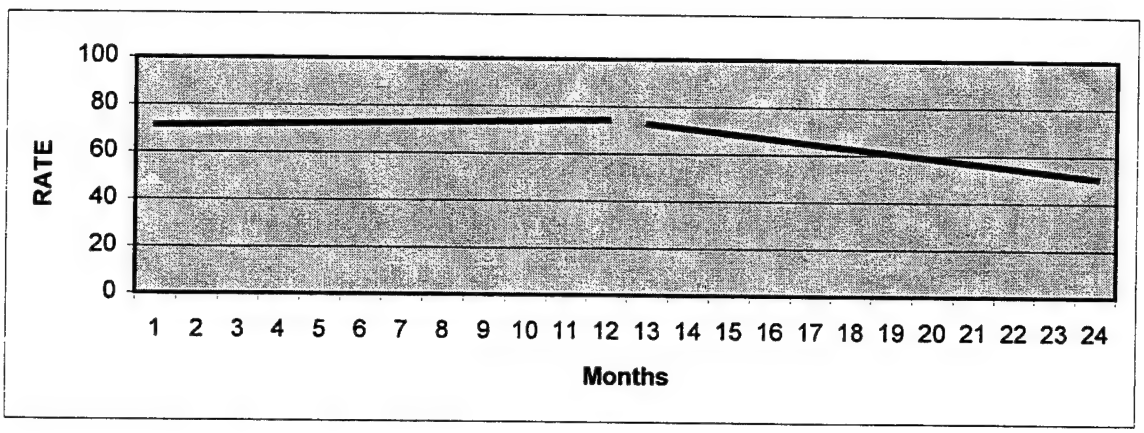


Figure 14. Piecewise Linear Regression
(A-10, Davis-Montham AFB)

The figure and the p-value associated with the X2 variable (.9183) clearly indicated that there was not a significant jump exhibited at the end of the first 12-month period. While there was not any movement between the two time periods, there was a

significant downward change in slope (see F-statistic). This change in the estimated line will need to be analyzed in comparison with the A-10 control groups to accurately determine the trends.

The A-10 control groups were the 23 FW at Pope AFB, the 57 FW at Nellis AFB, and the 347 FW at Moody AFB. Among these, Nellis (Figure 15) was the only control group to exhibit a significant decrease in the X2 variable. It had a p-value of .0277 and exhibited an estimated decrease in the RATE of 11.4855. Pope (Figure 16) and Moody (Figure 17) did not show significant decreases or p-values (7.31713, .0723 and 6.20583, .2690 respectively), and because of this their final models did not contain the X2 variable.

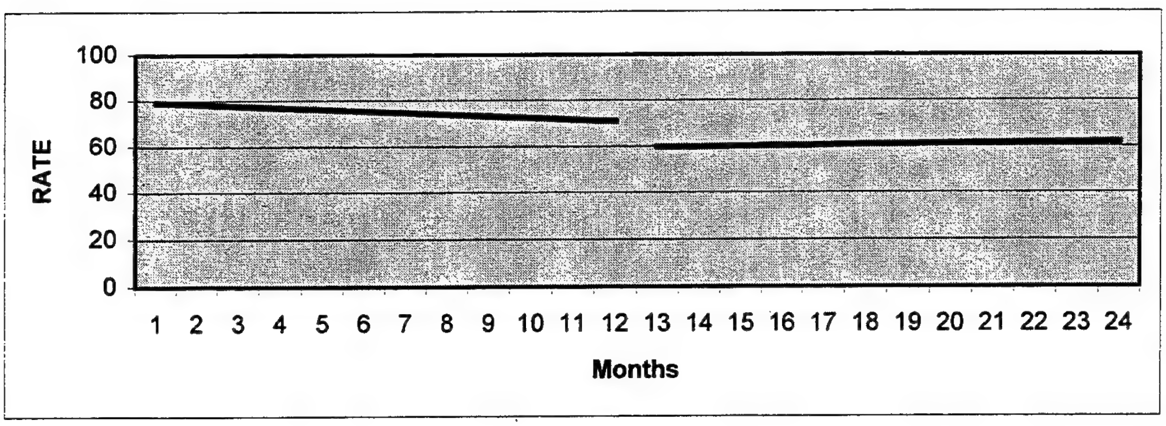


Figure 15. Piecewise Linear Regression
(A-10, Nellis AFB)

Analysis of the general linear test outputs for each of the three control units demonstrated that the change in slope from the first to the second 12-month period was not significant for Nellis or Pope, but was significant for Moody. For Nellis, the F-

statistics were 2.348 and .177 and for Pope they were .009 and .002, which were below the computed F-statistic level for this analysis. Therefore, the slopes for these two control units were approximately zero and required further analysis using the t-tests. For Moody, however, they were .02 and 8.391, which indicated a statistically significant change in slope from the first to the second time period.

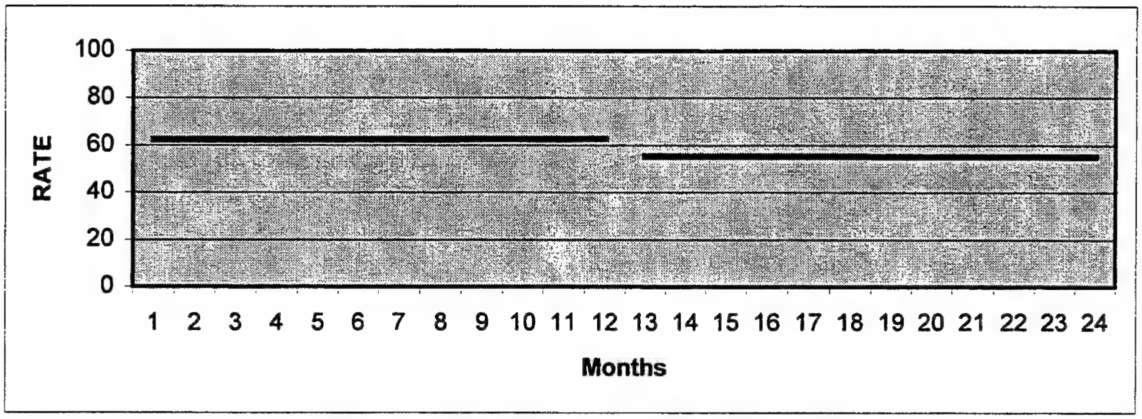


Figure 16. Piecewise Linear Regression
(A-10, Pope AFB)

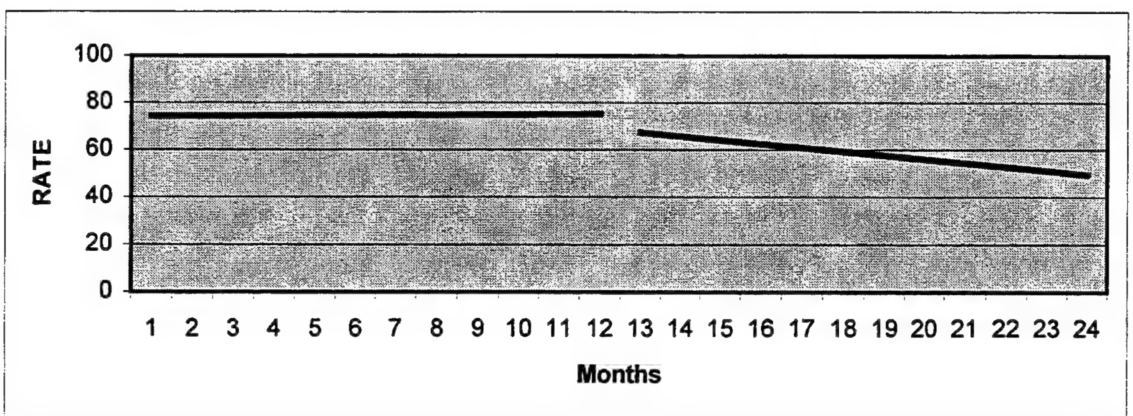


Figure 17. Piecewise Linear Regression
(A-10, Moody AFB)

Two-Sample T-Tests. Following the piecewise linear regression and general linear tests on each of the four A-10 units, the Wilk-Shapiro normality test and two-sample t-tests were accomplished. These tests were accomplished on the data sets exhibiting stationarity to determine if there was a statistically significant change in the mean of the RATE from before to after Action Workout implementation. Also available from these tests was a determination of the direction of this change, if any.

Table 21. General Linear Test Results (A-10)
(Highlighted unit conducted Action Workout)

Unit	Base	F-Statistic Prior to AWO	F-Statistic After AWO	Computed F-Statistic	Stationary?
355 FW	Davis-Montham	0.396	19.933	4.351	No
23 WG	Pope	0.009	0.0002	4.351	Yes
57 WG	Nellis	2.348	0.177	4.351	Yes
347 WG	Moody	0.02	8.391	4.351	No

Due to the requirement for stationarity in the two data sets, the unit of analysis, Davis-Montham, and one of the three control units, Moody, were determined to be Type I units and could not be analyzed using the two-sample t-test. The two remaining control units, however, were deemed Type II units and were analyzed. Each of the two units analyzed exhibited a significant decrease in the mean RATE. The printouts for these normality tests and two-sample t-tests can be found in Appendices D and E, respectively, while a brief synopsis of the results are in Tables 22 and 23 below.

Table 22. Wilk-Shapiro Test for Normality Results (A-10)

Unit	Base	Aircraft	Statistic	Normal?
23 WG	Pope	A-10	.9906	Yes
57 WG	Nellis	A-10	.9891	Yes

Table 23. Two-Sample T-Test Results (A-10)

Unit	Base	Before AWO Mean RATE	After AWO Mean RATE	Delta	Equal Variance	P-Value
57 WG	Nellis	75.117	60.825	-14.292	Yes	.0000
23 WG	Pope	62.542	55.317	-7.2250	Yes	.0007

Residual Analysis. For this study, standardized residual plots were examined (Appendix F) to determine if second-order terms were needed or outliers existed that skewed the data. The residual plots demonstrate that the residuals were relatively linear and did not require the introduction of second-order terms. The analysis of these residuals verified the homoscedasticity of the data and the aptness of the models used in this study.

Trend Analysis. As stated earlier, to determine the underlying trends displayed by piecewise linear regression and two-sample t-tests they need to be examined beyond the numbers they contain.

The trends contained in the regression analysis data from Davis-Montham AFB showed an increasing downward movement in the slope of the estimated line of the RATE during the time period following the Action Workout team visit. This, however,

could be attributed to many other factors affecting the A-10 fleet as a whole. To determine if this was a fleet-wide problem, trend analysis of the control groups was required.

The three A-10 control units tend to mirror the results obtained from Davis-Montham, but to a smaller degree. At Moody, while there was not a statistically significant decrease from the end of the first to the beginning of the second time period, the comparable slope from these two time periods changed significantly. At Pope, there was also no decrease from the end of the first to the beginning of the second time period, and relatively little change in the slope of the line of regression, but there was a slight decrease in the mean RATE (-7.2250). Finally, at Nellis, there was a significant decrease from the end of the first to the beginning of the second time period, and while the slope changed somewhat, it was not statistically significant, but what was significant was the drastic decrease in the mean of the RATE (-14.292).

Examined together, the trends for the four A-10 bases were not as dramatic as earlier trends in the data. It was evident that the unit of analysis, Davis-Montham AFB, exhibited a decrease in performance after implementation of the Action Workout Process. This, however, was mirrored by drop-offs in performance at the A-10 control units, although to a much lesser degree. Assuming each of these A-10 units operated under similar constraints, the fact that Davis-Montham's changes were similar to, and in some regards worse than, the three control units meant the Action Workout had little or no effect in improving the performance of the unit.

Summary

This chapter presented the research results. In doing so, it addressed and analyzed the fundamental question: "what is the impact of the Action Workout Process on aircraft mission-capability measures?"

Additionally, this chapter, using the data collected, accomplished a comprehensive quantitative and qualitative analysis of data from the five units of analysis and the eight control units. These findings were examined initially individually for autocorrelation. After this individual analysis, the units were grouped by aircraft type and regression analysis and general linear tests were conducted to determine whether there was a significant change in the slope or the means from before to after the Action Workout. Following this, tests for normality and t-tests were conducted where applicable. Next, residual analysis was done to ensure the data trends allowed for a closer fit to the regression line. Finally, trend analysis was conducted to assist in the managerial decision-making process, which is an integral part of the next chapter, needed to draw conclusions about the results.

V. Discussion

Introduction

This chapter discusses the conclusions and recommendations developed as a result of my research endeavor. It provides answers to the research questions and discusses the implications based on these answers. Finally, this chapter suggests areas of study future researchers should consider to expand this previously understudied field of research.

Discussion

The objective of this research was to determine whether the Phase and Isochronal inspection processes within the Air Force had delivered verifiable changes in performance due to the implementation of the Action Workout Process. To facilitate this determination three research questions were addressed:

1. Can the effects of the Action Workout be quantified and measured?
2. Was the Action Workout an effective means of improving aircraft performance?
3. What issues affect the relationship between the Action Workout Process and changes in the mission capability of aircraft?

The following paragraphs contain detailed answers to these research questions.

Can the effects of the Action Workout be quantified and measured? The answer to this question is contained in the literature review and the methodology

chapters. These chapters address this question by discussing past attempts at quantifying quality and by developing the parameters within which this study would be conducted. First, the literature review explored definitions contained in the literature and previous research efforts to help formulate the context and direction for this study. Using this data, I postulated how to quantify quality within the study. Next, the methodology chapter examined the units of analysis, choice of performance indicators, and data collection and analysis procedures. This examination provided the means to measure and analyze the data which, in turn, was used to draw constructive conclusions about how the Action Workout Process has affected aircraft performance factors.

Was the Action Workout an effective means of improving aircraft performance? In my research, I examined five units of analysis and eight control units. Using the overall RATE, created by subtracting aircraft Abort and Break rates from the aircraft Mission Capable rate, I was able to compare each unit to itself (before versus after the Action Workout) and to other units employing the same type of aircraft. Using this methodology, I found the Action Workout Process, in most cases, to be an effective means of improving aircraft performance. While it does not always improve performance at a particular base, it does mitigate the effects of factors conspiring to reduce performance. In this regard, the Action Workout Process is an effective quality improvement process.

What issues affect the relationship between the Action Workout Process and changes in the mission capability of aircraft? This study attempted to address this difficult question by including the control groups. Since this research was primarily concerned with how the Action Workout, by itself, affected the mission capability of

aircraft, all other issues were assumed to be relatively stable throughout the respective time periods. Analysis of additional issues affecting this relationship are very important, however, and are discussed in greater detail later in this chapter when recommendations for future research are proffered.

Implications

Overall, the results of this study provide mixed results on whether the Action Workout Process positively affects aircraft performance indicators. At the 366 WG, Mountain Home AFB, and the 57 WG, Nellis AFB, the results were very favorable. The F-15 unit at Mountain Home showed an increase in their RATE from before to after Action Workout implementation, while the three F-15 control units RATE declined or were relatively unchanged. Similarly, while the HH-60 unit at Nellis showed a slight decline in their RATE, in comparison to the two HH-60 control units, it did remarkably well.

This, however, was not the case at the other three units of analysis. At the 55 WG, Offutt AFB, and the 552 ACW, Tinker AFB, the analysis proved inconclusive. While the data revealed the RATE at the RC-135 unit at Offutt remained unchanged and the RATE at the E-3 unit at Tinker dropped somewhat, the lack of control units for these bases make the results inconclusive. Without some form of comparative analysis, useful conclusions about the effects of the Action Workout cannot be drawn when so many other factors may be responsible for the findings.

Finally, at the 355 FW, Davis-Montham AFB, the results differed dramatically. When compared to the three control units, the RATE at the A-10 unit at Davis-Montham

was much worse. While all four units saw a decline from the first to the second time period, Davis-Montham's decline was noticeably more severe.

The results of this study support previous research on the effects of Action Workouts on quality enhancements conducted by Malone (1998). Malone concluded there was "at least plausible evidence suggesting that quality enhancements can be realized as a result of Action Workouts" (Malone, 1998: 46-47), but this plausible evidence was only apparent at two of the three units of analysis. Interestingly, the unit whose quality scores remained virtually unchanged and was exhibiting several "decreasing trends" was the same unit exhibiting the most severe decline in my study, the 355 FW at Davis-Montham AFB.

Overall, the results of this study generally support the assertion that the Action Workout positively affects aircraft performance. This result, however, needs to be examined within various contexts to determine the true implications and effects of the Action Workout at both the Wing and Air Force levels. While it may improve performance, at what cost do we reap these rewards? Increased understanding of this relationship, taken together with the results of research conducted by Malone, myself, and others, should assist decision-makers in deciding the long-term fate of this quality improvement program.

Recommendations for Future Research

This study examined the effects of the Action Workout Process on aircraft performance indicators. Since examination of the Action Workout Process is a very

broad topic, with far-reaching implications, several other facets of this topic may justify further research. These areas include:

1. Longitudinal studies examining the long-term effects of the Action Workout Process. The data collected for this study and for Malone's research were limited because the nature of the time-series data involved did not permit the inclusion of additional observations. The relatively new application of the Action Workout Process within the Air Force limited the amount of data available after the improvement process was implemented. Continuation of the same or a similar analytical path may yield dramatically different results.
2. A study of other functions that have undergone the Action Workout improvement process. This study analyzed United States Air Force units possessing Phase or Isochronal aircraft inspection responsibilities that have implemented an Action Workout Process within the last four years. Yet ACC employs the Action Workout Process to improve a multitude of different functions within their command. Has the Action Workout improved performance in any of these other functions? Will the different methodologies used for these studies yield different results?
3. A study analyzing additional measurements used to determine aircraft performance. The number of performance measurements used to determine the trends limited this study. How do the inclusion of additional performance measurements change the outcomes of the models?
4. A study incorporating additional aircraft performance factors. This study analyzed performance measurement data collected and tabulated after the fact,

so to speak. What effects do factors such as transportation, supply, manning, and training have on aircraft performance? Also, is the level of these effects dependent on aircraft type or are they felt at varying degrees at the individual unit level?

5. A study where the independent variables are weighted based on their relative significance in the formulation of the final model. This study examined three independent variables whose weights were equal and independent of one another. Future studies may gain additional insight through an econometric approach whereby an empirical estimation of the relationships of the independent variables is obtained and used for final model construction.
6. A cost-benefit analysis of savings created by the Action Workout versus cost to implement and operate it. Are the costs invested in Action Workout programs ACC-wide offset by the manpower, supply, or time savings reaped from their implementation? Are the savings measurable as a quantifiable variable or are the benefits more of an intangible nature?
7. A qualitative study of the behavioral effects of Action Workout implementation. Does the introduction of a quality improvement process have any effect on the motivation, job satisfaction, or interpersonal skills of the personnel assigned to the unit of analysis?

Conclusion

This research explored the impact of the Action Workout Process on aircraft mission-capability measures; it accomplished this exploration effectively while

developing a foundation upon which future research in this area of quality improvement analysis can be based. Additionally, while the results of this study did not unequivocably endorse the Action Workout Process, the results do indicate performance at several bases was enhanced after implementation of this quality improvement process. Using these results as a baseline, future researchers can now take the next step -- a fuller understanding and quantification of the effects of quality improvement processes, such as the Action Workout, on organizational performance.

Appendix A: Source Data

Overall Action
Workout Comparison

ACTION WORKOUT UNITS

				Prior Year				Inspection Year				Following Year			
				MC	Abort	Break		MC	Abort	Break		MC	Abort	Break	
Base	Unit	Aircraft	Date of AWO	Rate	Rate	Rate	RATE	Rate	Rate	Rate	RATE	Rate	Rate	Rate	RATE
Mt Home	366 WG	F-15C/D	25-29 Mar 96	65.36	6.78	12.41	46.17	73.87	5.48	11.31	57.08	74.27	4.48	12.44	57.35
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	78.48	4.23	7.46	66.79	73.72	5.60	10.57	57.55	75.41	5.17	9.09	61.15
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	81.76	4.94	7.45	69.37	87.33	4.80	5.88	78.65	76.24	5.66	5.56	65.02
Tinker	552 ACW	E-3	4-8 Nov 96	81.61	7.03	25.70	48.88	77.93	5.94	28.33	43.66	70.78	8.83	35.45	26.50
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	86.41	4.18	9.43	72.80	83.56	3.24	9.81	70.51	74.33	3.99	8.61	61.73

CONTROL UNITS

			Prior Year				Inspection Year				Following Year			
			MC	Abort	Break		MC	Abort	Break		MC	Abort	Break	
Base	Unit	Aircraft	Rate	Rate	Rate	RATE	Rate	Rate	Rate	RATE	Rate	Rate	Rate	RATE
Langley	1 FW	F-15C/D	82.51	6.74	17.58	58.19	80.24	8.17	16.08	55.99	74.63	8.55	15.20	50.88
Eglin	33 FW	F-15C/D	80.64	4.45	20.28	55.91	79.55	6.50	19.83	53.22	80.22	6.23	16.22	57.77
Nellis	57 WG	F-15C/D	81.62	5.70	15.01	60.91	77.03	5.65	14.28	57.10	71.97	5.88	18.70	47.39
Moody	347 FW	HH-60	81.77	2.64	5.28	73.85	69.88	4.00	4.18	61.70	72.93	7.60	7.08	58.25
Holloman	49 FW	HH-60	83.23	0.58	3.35	79.30	75.39	0.96	3.20	71.23	70.85	1.73	7.60	61.52
Pope	23 WG	A-10	78.83	4.50	11.79	62.54	75.86	3.76	12.21	59.89	70.08	4.20	10.56	55.32
Nellis	57 WG	A-10	86.75	3.14	8.49	75.12	74.84	2.77	7.58	64.49	74.13	3.42	9.88	60.83
Moody	347 WG	A-10	83.99	2.84	6.43	74.72	73.12	4.29	8.16	60.67	72.13	4.31	9.35	58.47

MC Rate
12 Months Prior to Action Workout

ACTION WORKOUT UNITS

				Prior Year MC Rate												
Base	Unit	Aircraft	Date	1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	72.4	61.0	58.6	62.7	67.8	67.9	80.1	65.9	59.1	55.8	66.1	66.9	65.36
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	73.8	80.2	78.0	78.7	76.7	75.5	75.7	77.2	86.3	80.7	85.2	73.7	78.48
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	92.9	79.8	73.6	89.2	80.6	78.2	77.3	81.9	82.4	75.0	90.3	79.9	81.76
Tinker	552 ACW	E-3	4-8 Nov 96	81.8	86.4	85.6	83.9	84.9	82.2	81.5	85.9	79.3	80.2	78.0	69.6	81.61
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	86.0	86.7	80.9	84.7	89.0	87.7	86.4	88.6	90.9	84.2	87.8	84.0	86.41

CONTROL UNITS

			Prior Year MC Rate												
Base	Unit	Aircraft	1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	85.2	85.3	80.2	80.4	75.2	79.5	83.9	85.4	83.7	83.3	85.5	82.5	82.51
Eglin	33 FW	F-15C/D	83.7	83.3	81.8	83.6	82.2	83.2	75.9	75.7	78.3	81.0	80.2	78.8	80.64
Nellis	57 WG	F-15C/D	78.6	83.2	76.9	85.2	82.9	85.4	87.5	80.9	82.0	80.8	77.2	78.8	81.62
Moody	347 FW	HH-60	74.2	79.9	80.1	87.6	89.9	82.3	96.1	70.9	78.2	74.9	72.6	94.5	81.77
Holloman	49 FW	HH-60	88.1	86.5	79.2	66.5	81.8	75.9	84.4	95.4	85.2	94.7	81.4	79.6	83.23
Pope	23 WG	A-10	83.1	79.1	76.6	75.6	79.2	77.0	76.6	78.0	80.0	80.1	81.2	79.5	78.83
Nellis	57 WG	A-10	89.0	96.3	90.3	86.8	86.9	92.7	84.4	88.4	80.1	75.2	81.0	89.9	86.75
Moody	347 WG	A-10	82.1	86.0	82.0	76.6	89.5	86.1	84.4	93.8	84.4	80.7	80.6	81.7	83.99

MC Rate
12 Month Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Inspection Year MC Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	72.1	69.3	77.9	71.8	77.1	77.0	76.9	70.0	74.0	75.6	74.9	69.8	73.87
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	74.2	77.4	75.8	73.4	73.2	73.1	71.7	71.9	77.7	74.2	74.1	67.9	73.72
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	76.2	87.1	88.2	87.6	93.9	84.0	87.9	88.4	89.5	88.2	91.0	86.0	87.33
Tinker	552 ACW	E-3	4-8 Nov 96	69.7	76.2	78.3	80.3	83.1	81.8	77.0	79.5	76.4	85.2	78.4	69.3	77.93
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	82.2	93.7	86.9	86.7	95.1	89.6	79.2	83.3	78.7	66.1	79.2	82.0	83.56

CONTROL UNITS

Base	Unit	Aircraft	Inspection Year MC Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	75.1	77.6	79.2	85.9	81.4	82.4	81.3	81.9	81.8	82.6	75.4	78.3	80.24
Eglin	33 FW	F-15C/D	78.3	88.2	78.1	79.9	78.5	80.2	81.5	76.8	81.9	75.9	76.4	78.9	79.55
Nellis	57 WG	F-15C/D	78.6	82.5	73.2	68.1	77.2	72.9	78.7	84.3	76.3	76.4	80.9	75.2	77.03
Moody	347 FW	HH-60	89.9	82.9	63.7	72.0	56.6	60.4	65.9	60.2	75.1	66.2	76.2	69.4	69.88
Holloman	49 FW	HH-60	73.6	94.9	90.4	81.2	56.1	77.7	81.9	66.3	82.6	66.9	72.4	60.7	75.39
Pope	23 WG	A-10	79.5	80.1	76.1	73.5	70.6	70.6	74.5	78.9	74.0	80.1	82.1	70.3	75.86
Nellis	57 WG	A-10	88.4	79.5	79.7	73.0	69.5	77.9	79.7	70.9	72.6	62.6	72.6	71.7	74.84
Moody	347 WG	A-10	79.9	76.4	74.6	79.2	80.6	79.3	76.6	76.0	68.5	62.3	61.1	62.9	73.12

MC Rate
12 Months Following AWO Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Following Year MC Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	85.3	76.8	72.1	79.8	85.9	73.8	70.6	73.3	71.3	60.4	69.1	72.8	74.27
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	70.1	83.9	75.9	75.4	77.1	79.1	77.3	79.9	71.4	72.5	72.7	69.6	75.41
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	80.5	71.8	80.9	77.6	83.7	84.0	61.4	67.9	73.7	80.9	73.1	79.4	76.24
Tinker	552 ACW	E-3	4-8 Nov 96	68.1	70.2	74.9	74.9	74.6	74.0	72.3	66.0	70.1	65.7	67.1	71.5	70.78
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	89.1	83.9	72.1	81.0	76.4	76.0	74.3	73.7	68.7	61.3	64.1	71.4	74.33

CONTROL UNITS

Base	Unit	Aircraft	Following Year MC Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	80.1	75.8	76.5	73.3	68.0	72.1	78.9	71.6	76.1	75.6	75.0	72.6	74.63
Eglin	33 FW	F-15C/D	81.8	82.5	83.0	78.5	81.7	78.0	78.0	82.1	79.1	79.1	79.1	79.7	80.22
Nellis	57 WG	F-15C/D	85.6	78.8	71.1	65.9	70.1	74.6	71.9	72.4	74.8	65.2	66.1	67.1	71.97
Moody	347 FW	HH-60	74.2	64.9	81.6	76.1	84.6	80.3	71.0	75.9	71.4	66.4	58.1	70.7	72.93
Holloman	49 FW	HH-60	65.8	51.2	52.1	67.0	63.7	78.4	84.6	86.3	88.5	62.7	73.1	76.8	70.85
Pope	23 WG	A-10	65.5	68.5	73.8	66.8	70.8	72.0	74.4	74.5	72.8	70.1	64.6	67.1	70.08
Nellis	57 WG	A-10	70.7	77.7	70.5	68.2	67.3	72.5	80.7	80.9	76.4	75.5	78.0	71.1	74.13
Moody	347 WG	A-10	67.9	82.9	80.5	83.8	74.9	71.8	63.0	75.5	66.5	68.5	60.8	69.5	72.13

Abort Rate
12 Months Prior to Action Workout

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Prior Year Abort Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	4.4	3.7	4.2	6.2	6.2	7.0	7.8	10.7	7.3	6.8	7.4	9.6	6.78
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	3.8	3.7	2.4	2.3	4.2	4.8	3.8	5.3	5.3	5.3	3.9	5.9	4.23
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	8.6	7.9	4.0	7.0	2.8	5.8	6.9	6.8	0.0	1.8	2.0	5.7	4.94
Tinker	552 ACW	E-3	4-8 Nov 96	5.8	8.0	5.3	6.5	5.4	6.0	7.5	6.2	11.1	8.6	5.3	8.6	7.03
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	4.2	4.1	5.7	3.6	2.3	3.2	4.1	2.7	3.7	6.6	4.0	6.0	4.18

CONTROL UNITS

Base	Unit	Aircraft	Prior Year Abort Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	3.8	3.9	5.4	6.0	8.4	8.8	9.7	5.8	9.2	7.9	6.8	5.2	6.74
Eglin	33 FW	F-15C/D	4.5	6.2	5.6	2.4	2.8	1.2	2.5	2.1	6.5	7.7	6.5	5.4	4.45
Nellis	57 WG	F-15C/D	3.9	4.8	5.8	6.6	5.3	5.9	3.3	6.1	6.7	8.0	6.4	5.6	5.70
Moody	347 FW	HH-60	0.0	3.3	2.2	0.0	2.2	3.3	7.3	7.6	2.0	1.7	1.2	0.9	2.64
Holloman	49 FW	HH-60	0.0	1.3	2.9	0.0	1.6	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.58
Pope	23 WG	A-10	3.7	3.8	3.7	2.5	7.2	5.4	6.2	7.2	2.9	4.7	5.0	1.7	4.50
Nellis	57 WG	A-10	2.6	5.6	5.3	2.8	4.3	1.2	1.7	1.8	1.1	3.6	4.8	2.9	3.14
Moody	347 WG	A-10	3.7	2.2	2.9	5.6	2.2	3.9	3.0	0.9	2.8	3.4	1.5	2.0	2.84

Abort Rate
12 Month Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Inspection Year Abort Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	4.9	4.5	3.0	6.1	4.3	7.3	7.2	5.0	6.3	5.2	6.8	5.1	5.48
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	1.7	4.0	7.1	7.8	7.6	5.5	8.6	5.9	4.4	6.7	0.0	7.9	5.60
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	8.4	7.6	6.4	1.7	2.9	7.4	2.9	4.1	3.0	6.4	4.8	2.0	4.80
Tinker	552 ACW	E-3	4-8 Nov 96	7.6	7.0	4.3	5.8	4.1	7.9	7.2	4.3	6.7	4.6	5.0	6.6	5.94
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	2.1	1.8	2.8	2.8	0.8	4.8	3.5	2.3	2.1	4.8	4.6	6.5	3.24

CONTROL UNITS

Base	Unit	Aircraft	Inspection Year Abort Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	8.0	6.7	7.9	6.6	5.6	6.3	8.3	6.6	11.2	12.8	8.8	9.2	8.2
Eglin	33 FW	F-15C/D	3.6	4.7	6.4	7.9	6.3	4.1	5.9	8.5	4.9	9.1	8.6	8.0	6.5
Nellis	57 WG	F-15C/D	3.1	6.2	8.1	5.3	5.5	6.5	2.5	7.6	4.2	5.2	4.3	9.3	5.7
Moody	347 FW	HH-60	0.0	4.0	4.2	1.4	7.3	3.6	0.0	1.6	7.9	3.2	7.3	7.5	4.0
Holloman	49 FW	HH-60	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	2.6	3.1	2.7	1.7	1.0
Pope	23 WG	A-10	2.2	5.0	5.1	3.2	3.2	4.1	1.4	3.1	4.4	4.4	2.9	6.1	3.8
Nellis	57 WG	A-10	0.9	2.1	4.4	2.0	5.1	1.4	1.4	4.6	2.6	1.8	3.9	3.0	2.8
Moody	347 WG	A-10	2.8	5.8	4.2	4.5	3.3	4.0	4.3	2.8	3.1	5.7	6.1	4.9	4.3

Abort Rate
12 Months Following AWO Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Following Year Abort Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	3.8	8.2	4.9	7.0	4.7	3.1	4.9	3.5	3.6	5.9	1.0	3.1	4.48
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	6.7	6.2	2.6	6.0	5.1	5.1	7.7	3.2	8.2	0.8	3.1	7.3	5.17
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	3.6	4.3	7.7	7.8	6.6	7.4	3.1	8.6	4.1	3.1	6.9	4.7	5.66
Tinker	552 ACW	E-3	4-8 Nov 96	9.6	5.9	7.8	8.1	9.9	4.8	8.4	7.7	15.8	13.9	8.0	6.1	8.83
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	2.0	7.2	4.8	4.5	2.4	2.6	3.8	4.5	3.1	6.0	4.7	2.3	3.99

CONTROL UNITS

Base	Unit	Aircraft	Following Year Abort Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	6.7	8.4	5.8	9.0	7.3	7.0	7.1	11.6	10.3	9.0	11.0	9.4	8.55
Eglin	33 FW	F-15C/D	5.9	6.2	4.8	5.7	6.2	6.2	5.3	7.2	6.5	5.6	9.3	5.8	6.23
Nellis	57 WG	F-15C/D	6.2	7.1	6.6	8.1	8.1	3.7	2.0	10.5	4.1	5.6	7.0	1.6	5.88
Moody	347 FW	HH-60	14.2	8.6	8.2	7.1	9.0	12.4	12.1	5.8	4.9	1.0	3.3	4.6	7.60
Holloman	49 FW	HH-60	0.0	4.8	2.9	2.9	3.4	0.0	0.0	0.0	0.0	1.4	2.3	3.0	1.73
Pope	23 WG	A-10	2.7	4.3	5.4	3.3	4.8	4.9	5.7	3.4	2.9	3.6	5.1	4.3	4.20
Nellis	57 WG	A-10	0.6	2.5	2.7	3.3	0.6	8.1	3.9	6.1	2.2	5.8	2.8	2.4	3.42
Moody	347 WG	A-10	2.3	4.6	4.9	3.2	3.8	4.8	6.7	4.0	6.6	4.4	2.4	4.0	4.31

Break Rate
12 Months Prior to Action Workout

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Prior Year Break Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	13.0	12.5	13.9	11.6	14.1	12.3	14.8	10.7	11.2	11.4	11.5	11.9	12.4
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	5.4	6.8	8.3	4.7	4.3	8.9	6.9	6.2	12.1	8.7	6.3	10.9	7.5
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	7.3	8.1	6.1	8.0	10.1	14.0	8.7	5.8	5.3	6.3	4.0	5.7	7.5
Tinker	552 ACW	E-3	4-8 Nov 96	27.5	26.1	22.4	26.1	22.5	19.4	27.5	26.0	28.6	29.0	24.2	29.1	25.7
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	8.8	15.0	9.4	10.1	9.2	9.4	8.5	7.6	10.6	6.0	7.6	11.0	9.4

CONTROL UNITS

Base	Unit	Aircraft	Prior Year Break Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	12.7	12.5	13.3	18.9	22.7	21.0	21.3	20.4	18.8	17.2	16.5	15.6	17.58
Eglin	33 FW	F-15C/D	22.3	19.2	18.3	21.4	18.3	16.5	18.3	21.4	17.2	25.5	24.6	20.4	20.28
Nellis	57 WG	F-15C/D	10.9	16.7	19.6	17.9	17.6	11.8	7.8	13.4	11.9	16.2	21.3	15.0	15.01
Moody	347 FW	HH-60	6.5	1.7	5.6	2.7	9.8	9.8	3.8	7.6	1.0	7.7	3.7	3.5	5.28
Holloman	49 FW	HH-60	0.0	3.8	1.0	0.0	8.1	7.1	1.4	2.5	4.8	3.8	5.1	2.6	3.35
Pope	23 WG	A-10	9.0	8.9	12.8	13.9	11.8	16.0	12.7	11.8	11.9	9.8	13.0	9.9	11.79
Nellis	57 WG	A-10	9.3	7.7	10.3	8.4	7.6	6.3	12.4	8.1	7.0	9.2	8.2	7.4	8.49
Moody	347 WG	A-10	6.7	4.8	5.5	6.9	10.0	6.9	5.4	3.9	6.2	7.8	7.1	6.0	6.43

Break Rate
12 Month Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Inspection Year Break Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	9.2	9.3	9.4	9.2	14.6	13.1	12.9	10.8	17.1	9.4	10.9	9.8	11.31
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	10.2	11.3	9.7	14.3	15.9	12.2	9.6	9.6	7.0	9.8	6.9	10.3	10.57
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	10.3	3.4	5.2	5.9	4.0	6.2	9.1	3.0	3.1	7.1	8.1	5.1	5.88
Tinker	552 ACW	E-3	4-8 Nov 96	26.5	27.8	30.3	24.1	22.2	29.9	31.1	26.0	34.8	27.1	28.6	31.6	28.33
Davis-Montham	355 FW(Ops)	A-10	19-23 May 97	10.4	6.9	10.7	9.6	5.3	9.4	9.8	9.4	9.6	13.7	11.3	11.6	9.81

CONTROL UNITS

Base	Unit	Aircraft	Inspection Year Break Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	13.9	16.1	16.1	18.0	18.8	17.4	20.2	14.0	13.5	14.4	15.9	14.6	16.08
Eglin	33 FW	F-15C/D	16.0	19.4	25.7	23.2	20.4	17.0	19.3	15.4	16.4	19.0	25.7	20.4	19.83
Nellis	57 WG	F-15C/D	15.7	11.6	18.8	16.5	16.0	12.8	9.2	14.4	14.7	13.7	14.2	13.7	14.28
Moody	347 FW	HH-60	1.2	2.0	4.2	1.4	8.9	3.6	2.2	3.3	9.5	8.1	1.9	3.8	4.18
Holloman	49 FW	HH-60	0.0	6.3	6.3	2.4	1.4	3.7	2.8	1.3	0.9	6.3	3.6	3.4	3.20
Pope	23 WG	A-10	9.9	8.7	13.6	11.5	10.6	18.1	11.7	10.0	13.1	14.9	13.1	11.3	12.21
Nellis	57 WG	A-10	10.4	6.5	7.8	9.5	8.7	6.6	5.3	3.1	7.0	9.4	8.1	8.5	7.58
Moody	347 WG	A-10	9.4	8.5	8.5	9.9	5.6	8.5	7.4	6.7	7.1	9.1	7.9	9.3	8.16

Break Rate
12 Months Following AWO Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Following Year Break Rate												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	8.8	16.2	20.7	16.0	8.6	8.8	18.1	11.6	9.3	11.0	11.8	8.4	12.44
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	17.3	4.5	3.6	12.9	10.3	12.1	11.2	5.2	4.2	6.3	6.1	15.4	9.09
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	6.1	8.8	8.7	7.2	4.8	6.2	5.4	5.1	4.2	1.6	7.0	1.6	5.56
Tinker	552 ACW	E-3	4-8 Nov 96	38.0	36.2	36.1	35.2	36.0	26.0	30.2	30.6	41.7	38.5	44.0	32.9	35.45
Davis-Montham	355 FW (Ops)	A-10	19-23 May 97	5.6	5.6	8.9	12.0	6.9	7.1	10.9	11.1	7.9	9.0	10.0	8.3	8.61

CONTROL UNITS

Base	Unit	Aircraft	Following Year Break Rate												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	10.6	15.0	9.4	11.5	14.5	12.1	14.4	18.0	20.6	16.8	21.5	18.0	15.20
Eglin	33 FW	F-15C/D	16.8	12.6	13.2	17.1	16.9	18.1	12.2	15.2	16.5	21.9	18.8	15.3	16.22
Nellis	57 WG	F-15C/D	11.9	17.9	12.4	15.6	20.1	19.0	12.7	22.2	13.6	30.0	26.4	22.6	18.70
Moody	347 FW	HH-60	11.3	6.0	6.8	4.8	6.2	7.5	8.3	7.0	3.0	10.1	5.9	8.1	7.08
Holloman	49 FW	HH-60	3.4	8.5	10.8	6.0	6.1	2.7	16.7	8.5	13.6	8.7	1.6	4.6	7.60
Pope	23 WG	A-10	8.6	11.9	11.0	11.6	12.9	10.2	9.8	8.8	9.4	8.3	11.8	12.4	10.56
Nellis	57 WG	A-10	6.3	10.1	8.6	8.7	14.5	12.9	9.6	12.3	6.5	9.7	9.1	10.3	9.88
Moody	347 WG	A-10	5.9	10.0	9.3	8.6	6.5	9.0	11.4	7.8	11.2	11.6	11.7	9.2	9.35

RATE
12 Months Prior to Action Workout

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Prior Year RATE 1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	55.0	44.8	40.5	44.9	47.5	48.6	57.5	44.5	40.6	37.6	47.2	45.4	46.17
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	64.6	69.7	67.3	71.7	68.2	61.8	65.0	65.7	68.9	66.7	75.0	56.9	66.79
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	77.0	63.8	63.5	74.2	67.7	58.4	61.7	69.3	77.1	66.9	84.3	68.5	69.37
Tinker	552 ACW	E-3	4-8 Nov 96	48.5	52.3	57.9	51.3	57.0	56.8	46.5	53.7	39.6	42.6	48.5	31.9	48.88
Davis-Montham	355 FW (Ops)	A-10	19-23 May 97	73.0	67.6	65.8	71.0	77.5	75.1	73.8	78.3	76.6	71.6	76.2	67.0	72.80

CONTROL UNITS

Base	Unit	Aircraft	Prior Year RATE 1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	68.7	68.9	61.5	55.5	44.1	49.7	52.9	59.2	55.7	58.2	62.2	61.7	58.19
Eglin	33 FW	F-15C/D	56.9	57.9	57.9	59.8	61.1	65.5	55.1	52.2	54.6	47.8	49.1	53.0	55.91
Nellis	57 WG	F-15C/D	63.8	61.7	51.5	60.7	60.0	67.7	76.4	61.4	63.4	56.6	49.5	58.2	60.91
Moody	347 FW	HH-60	67.7	74.9	72.3	84.9	77.9	69.2	85.0	55.7	75.2	65.5	67.7	90.1	73.85
Holloman	49 FW	HH-60	88.1	81.4	75.3	66.5	72.1	68.8	83.0	91.7	80.4	90.9	76.3	77.0	79.30
Pope	23 WG	A-10	70.4	66.4	60.1	59.2	60.2	55.6	57.7	59.0	65.2	65.6	63.2	67.9	62.54
Nellis	57 WG	A-10	77.1	83.0	74.7	75.6	75.0	85.2	70.3	78.5	72.0	62.4	68.0	79.6	75.12
Moody	347 WG	A-10	71.7	79.0	73.6	64.1	77.3	75.3	76.0	89.0	75.4	69.5	72.0	73.7	74.72

RATE
12 Month Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Inspection Year RATE 1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	58.0	55.5	65.5	56.5	58.2	56.6	56.8	54.2	50.6	61.0	57.2	54.9	57.08
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	62.3	62.1	59.0	51.3	49.7	55.4	53.5	56.4	66.3	57.7	67.2	49.7	57.55
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	57.5	76.1	76.6	80.0	87.0	70.4	75.9	81.3	83.4	74.7	78.1	78.9	76.65
Tinker	552 ACW	E-3	4-8 Nov 96	35.6	41.4	43.7	50.4	56.8	44.0	38.7	49.2	34.9	53.5	44.8	30.9	43.66
Davis-Montham	355 FW (Ops)	A-10	19-23 May 97	69.7	85.0	73.4	74.3	89.0	75.4	65.9	71.6	67.0	47.6	63.3	63.9	70.51

CONTROL UNITS

Base	Unit	Aircraft	Ispection Year RATE 1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	53.2	54.8	55.2	61.3	57.0	58.7	52.8	61.3	57.1	55.4	50.7	54.5	55.99
Eglin	33 FW	F-15C/D	58.7	64.1	46.0	48.8	51.8	59.1	56.3	52.9	60.6	47.8	42.1	50.5	53.22
Nellis	57 WG	F-15C/D	59.8	64.7	46.3	46.3	55.7	53.6	67.0	62.3	57.4	57.5	62.4	52.2	57.10
Moody	347 FW	HH-60	88.7	76.9	55.3	69.2	40.4	53.2	63.7	55.3	57.7	54.9	67.0	58.1	61.70
Holloman	49 FW	HH-60	73.6	88.6	84.1	78.8	53.3	74.0	79.1	65.0	79.1	57.5	66.1	55.6	71.23
Pope	23 WG	A-10	67.4	66.4	57.4	58.8	56.8	48.4	61.4	65.8	56.5	60.8	66.1	52.9	59.89
Nellis	57 WG	A-10	77.1	70.9	67.5	61.5	55.7	69.9	73.0	63.2	63.0	51.4	60.6	60.2	64.49
Moody	347 WG	A-10	67.7	62.1	61.9	64.8	71.7	66.8	64.9	66.5	58.3	47.5	47.1	48.7	60.67

RATE
12 Months Following AWO Transition Period

ACTION WORKOUT UNITS

Base	Unit	Aircraft	Date	Following Year RATE												
				1	2	3	4	5	6	7	8	9	10	11	12	Rate
Mt Home	366 WG	F-15C/D	25-29 Mar 96	72.7	52.4	46.5	56.8	72.6	61.9	47.6	58.2	58.4	43.5	56.3	61.3	57.35
Offutt	55 WG	RC-135	29 Jul - 2 Aug 96	46.1	73.2	69.7	56.5	61.7	61.9	58.4	71.5	59.0	65.4	63.5	46.9	61.15
Nellis	57 WG (66 RQS)	HH-60	12-16 Aug 96	70.8	58.7	64.5	62.6	72.3	70.4	52.9	54.2	65.4	76.2	59.2	73.1	65.02
Tinker	552 ACW	E-3	4-8 Nov 96	20.5	28.1	31.0	31.6	28.7	43.2	33.7	27.7	12.6	13.3	15.1	32.5	26.50
Davis-Montham	355 FW (Ops)	A-10	19-23 May 97	81.5	71.1	58.4	64.5	67.1	66.3	59.6	58.1	57.7	46.3	49.4	60.8	61.73

CONTROL UNITS

Base	Unit	Aircraft	Following Year RATE												
			1	2	3	4	5	6	7	8	9	10	11	12	Rate
Langley	1 FW	F-15C/D	62.8	52.4	61.3	52.8	46.2	53.0	57.4	42.0	45.2	49.8	42.5	45.2	50.88
Eglin	33 FW	F-15C/D	59.1	63.7	65.0	55.7	58.6	53.7	60.5	59.7	56.1	51.6	51.0	58.6	57.77
Nellis	57 WG	F-15C/D	67.5	53.8	52.1	42.2	41.9	51.9	57.2	39.7	57.1	29.6	32.7	42.9	47.39
Moody	347 FW	HH-60	48.7	50.3	66.6	64.2	69.4	60.4	50.6	63.1	63.5	55.3	48.9	58.0	58.25
Holloman	49 FW	HH-60	62.4	37.9	38.4	58.1	54.2	75.7	67.9	77.8	74.9	52.6	69.2	69.2	61.52
Pope	23 WG	A-10	54.2	52.3	57.4	51.9	53.1	56.9	58.9	62.3	60.5	58.2	47.7	50.4	55.32
Nellis	57 WG	A-10	63.8	65.1	59.2	56.2	52.2	51.5	67.2	62.5	67.7	60.0	66.1	58.4	60.83
Moody	347 WG	A-10	59.7	68.3	66.3	72.0	64.6	58.0	44.9	63.7	48.7	52.5	46.7	56.3	58.48

Appendix B: Correlograms

Mountain Home AFB/F-15

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.264                 >         ********  <
   2  -0.077                >        ***          <
   3   0.098                >          ***        <
   4   0.220                >          ******     <
   5  -0.025                >         **          <
   6   0.150                >          *****      <
   7   0.137                >          ****       <
   8  -0.118               >        ****           <
   9  -0.264               >    ********           <

MEAN OF THE SERIES     51.7625
STD. DEV. OF SERIES    9.23011
NUMBER OF CASES             24
```

Langley AFB/F-15

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.540                 >         **********>***
   2   0.221              >            *******      <
   3   0.143              >            *****        <
   4  -0.034              >           **            <
   5  -0.149              >        *****            <
   6  -0.032              >           **            <
   7  -0.003              >            *            <
   8  -0.126              >         ****            <
   9  -0.040              >           **            <

MEAN OF THE SERIES     54.5375
STD. DEV. OF SERIES    7.74160
NUMBER OF CASES             24
```

Eglin AFB/F-15

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1    0.479                 >         **********>**
   2    0.085               >           ***         <
   3   -0.246               >     *******           <
   4   -0.354              >   **********            <
   5   -0.297             >      ********             <
   6   -0.262             >      ********             <
   7   -0.228            >        *******              <
   8   -0.140            >           ****              <
   9    0.009            >              *              <

MEAN OF THE SERIES     56.8417
STD. DEV. OF SERIES    4.60931
NUMBER OF CASES             24
```

Nellis AFB/F-15

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1    0.510                 >         **********>***
   2    0.352               >           **********  <
   3    0.219              >            ******       <
   4    0.122             >             ****          <
   5    0.252             >             *******       <
   6    0.402             >             ***********   <
   7    0.140            >              ****           <
   8    0.041            >              **             <
   9   -0.184            >         ******              <

MEAN OF THE SERIES     54.1458
STD. DEV. OF SERIES    11.1649
NUMBER OF CASES             24
```

Offutt AFB/RC-135

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1  -0.023                 >        **         <
   2  -0.264                 >  ********         <
   3   0.189                >          ******     <
   4  -0.089                >        ***          <
   5   0.122                >          ****       <
   6   0.218                >          ******     <
   7  -0.004               >           *           <
   8  -0.005               >           *           <
   9  -0.094               >         ***           <

MEAN OF THE SERIES     63.9708
STD. DEV. OF SERIES    7.19609
NUMBER OF CASES             24
```

Nellis AFB/HH-60

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.040                 >         **        <
   2  -0.085                 >       ***         <
   3  -0.170                 >     *****         <
   4   0.086                 >         ***       <
   5  -0.144                 >     *****         <
   6  -0.053                >         **          <
   7   0.085                >          ***        <
   8  -0.126                >       ****          <
   9  -0.065                >        ***          <

MEAN OF THE SERIES     67.1958
STD. DEV. OF SERIES    7.58642
NUMBER OF CASES             24
```

Moody AFB/HH-60

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.183                 >         ******    <
   2   0.154                 >         *****     <
   3   0.277                >          ********   <
   4   0.011                >          *          <
   5   0.447                >          ***********<
   6   0.037              >            **           <
   7  -0.095              >          ***            <
   8   0.131              >            ****         <
   9  -0.024              >           **            <

MEAN OF THE SERIES     66.0458
STD. DEV. OF SERIES    11.3312
NUMBER OF CASES             24
```

Hollomon AFB/HH-60

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.587                 >         **********>*****
   2   0.343              >            **********   <
   3   0.046             >             **            <
   4  -0.225             >       *******             <
   5  -0.217             >        ******             <
   6  -0.242            >        *******              <
   7  -0.116            >           ****              <
   8   0.076            >              ***            <
   9   0.060            >              ***            <

MEAN OF THE SERIES     70.4083
STD. DEV. OF SERIES    13.9599
NUMBER OF CASES             24
```

Tinker AFB/E-3

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.782                 >         **********>**********
   2   0.587            >              ***************<
   3   0.415          >                ***********      <
   4   0.286         >                 ********          <
   5   0.189         >                 ******            <
   6   0.154        >                  *****              <
   7   0.130        >                  ****               <
   8   0.093        >                  ***                <
   9   0.010        >                  *                  <

MEAN OF THE SERIES     37.6917
STD. DEV. OF SERIES    13.8924
NUMBER OF CASES             24
```

Davis-Montham AFB/A-10

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.691                 >         **********>*******
   2   0.487             >             ************* <
   3   0.438           >               ************    <
   4   0.344          >                **********       <
   5   0.233          >                *******          <
   6   0.095         >                 ***               <
   7   0.087         >                 ***               <
   8   0.008         >                 *                 <
   9  -0.210         >            ******                 <

MEAN OF THE SERIES     67.2625
STD. DEV. OF SERIES    8.90884
NUMBER OF CASES             24
```

Pope AFB/A-10

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.496                 >         **********>**
   2   0.093               >           ***         <
   3  -0.048               >          **           <
   4  -0.255               >     *******           <
   5  -0.233              >      *******            <
   6  -0.079              >          ***            <
   7   0.137              >            ****         <
   8   0.266              >            ********     <
   9   0.303             >             *********     <

MEAN OF THE SERIES     58.9292
STD. DEV. OF SERIES    5.60859
NUMBER OF CASES             24
```

Nellis AFB/A-10

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.568                 >         **********>****
   2   0.513              >            *************>
   3   0.381            >              ***********    <
   4   0.353           >               **********      <
   5   0.188           >               ******          <
   6   0.232          >                *******          <
   7   0.163          >                *****            <
   8  -0.032          >               **                <
   9  -0.155          >            *****                <

MEAN OF THE SERIES     67.9708
STD. DEV. OF SERIES    9.14720
NUMBER OF CASES             24
```

Moody AFB/A-10

```
AUTOCORRELATION PLOT FOR RATE

            -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
 LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
   1   0.617                  >        *********>*****
   2   0.531               >           *************>
   3   0.431             >             ************    <
   4   0.384            >              ***********      <
   5   0.234           >               *******           <
   6   0.217          >                ******             <
   7   0.001          >                *                  <
   8   0.010          >                *                  <
   9  -0.016          >                *                  <

MEAN OF THE SERIES       66.5958
STD. DEV. OF SERIES      10.8763
NUMBER OF CASES               24
```

Appendix C: Piecewise Linear Regression Printouts

Mountain Home AFB/F-15
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	49.0364	4.81175	10.19	0.0000	
MONTH	-0.44021	0.65379	-0.67	0.5084	8.0
X1	-0.12203	0.92460	-0.13	0.8963	5.5
X2	17.2507	6.41691	2.69	0.0141	4.0

R-SQUARED	0.4021	RESID. MEAN SQUARE (MSE)	61.1239
ADJUSTED R-SQUARED	0.3124	STANDARD DEVIATION	7.81818

SOURCE	DF	SS	MS	F	P
REGRESSION	3	822.199	274.066	4.48	0.0146
RESIDUAL	20	1222.48	61.1239		
TOTAL	23	2044.68			

CASES INCLUDED 24 MISSING CASES 0

Langley AFB/F-15
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	60.7121	3.90072	15.56	0.0000	
MONTH	-0.38776	0.53000	-0.73	0.4729	8.0
X1	-1.04371	0.74954	-1.39	0.1791	5.5
X2	4.12890	5.20195	0.79	0.4367	4.0

R-SQUARED	0.4415	RESID. MEAN SQUARE (MSE)	40.1691
ADJUSTED R-SQUARED	0.3577	STANDARD DEVIATION	6.33791

SOURCE	DF	SS	MS	F	P
REGRESSION	3	634.993	211.664	5.27	0.0077
RESIDUAL	20	803.383	40.1691		
TOTAL	23	1438.38			

CASES INCLUDED 24 MISSING CASES 0

Langley AFB/F-15
Reduced Model (1)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	59.6906	3.64970	16.35	0.0000	
MONTH	-0.15203	0.43509	-0.35	0.7303	5.5
X1	-1.00085	0.74097	-1.35	0.1912	5.5

R-SQUARED	0.4239	RESID. MEAN SQUARE (MSE)	39.4614
ADJUSTED R-SQUARED	0.3690	STANDARD DEVIATION	6.28183

SOURCE	DF	SS	MS	F	P
REGRESSION	2	609.687	304.844	7.73	0.0031
RESIDUAL	21	828.689	39.4614		
TOTAL	23	1438.38			

CASES INCLUDED 24 MISSING CASES 0

Langley AFB/F-15
Reduced Model (2)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	63.0848	2.69599	23.40	0.0000
MONTH	-0.68378	0.18868	-3.62	0.0015

R-SQUARED	0.3738	RESID. MEAN SQUARE (MSE)	40.9402
ADJUSTED R-SQUARED	0.3454	STANDARD DEVIATION	6.39845

SOURCE	DF	SS	MS	F	P
REGRESSION	1	537.692	537.692	13.13	0.0015
RESIDUAL	22	900.684	40.9402		
TOTAL	23	1438.38			

CASES INCLUDED 24 MISSING CASES 0

Eglin AFB/F-15
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	61.7242	2.39762	25.74	0.0000	
MONTH	-0.89476	0.32577	-2.75	0.0124	8.0
X1	0.19021	0.46071	0.41	0.6841	5.5
X2	11.3674	3.19744	3.56	0.0020	4.0

R-SQUARED	0.4047	RESID. MEAN SQUARE (MSE)	15.1762
ADJUSTED R-SQUARED	0.3154	STANDARD DEVIATION	3.89567

SOURCE	DF	SS	MS	F	P
REGRESSION	3	206.374	68.7912	4.53	0.0140
RESIDUAL	20	303.525	15.1762		
TOTAL	23	509.898			

CASES INCLUDED 24   MISSING CASES 0

Nellis AFB/F-15
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	63.3924	5.06475	12.52	0.0000	
MONTH	-0.38217	0.68816	-0.56	0.5848	8.0
X1	-1.52273	0.97321	-1.56	0.1334	5.5
X2	0.95874	6.75429	0.14	0.8885	4.0

R-SQUARED	0.5473	RESID. MEAN SQUARE (MSE)	67.7203
ADJUSTED R-SQUARED	0.4794	STANDARD DEVIATION	8.22924

SOURCE	DF	SS	MS	F	P
REGRESSION	3	1637.33	545.778	8.06	0.0010
RESIDUAL	20	1354.41	67.7203		
TOTAL	23	2991.74			

CASES INCLUDED 24   MISSING CASES 0

Nellis AFB/F-15
Reduced Model (1)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	63.1552	4.66826	13.53	0.0000	
MONTH	-0.32743	0.55651	-0.59	0.5626	5.5
X1	-1.51277	0.94776	-1.60	0.1254	5.5

R-SQUARED	0.5468	RESID. MEAN SQUARE (MSE)	64.5605
ADJUSTED R-SQUARED	0.5037	STANDARD DEVIATION	8.03496

SOURCE	DF	SS	MS	F	P
REGRESSION	2	1635.97	817.984	12.67	0.0002
RESIDUAL	21	1355.77	64.5605		
TOTAL	23	2991.74			

CASES INCLUDED 24   MISSING CASES 0

Nellis AFB/F-15
Reduced Model (2)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	68.2855	3.50260	19.50	0.0000
MONTH	-1.13117	0.24513	-4.61	0.0001

R-SQUARED	0.4919	RESID. MEAN SQUARE (MSE)	69.1024
ADJUSTED R-SQUARED	0.4688	STANDARD DEVIATION	8.31278

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1471.49	1471.49	21.29	0.0001
RESIDUAL	22	1520.25	69.1024		
TOTAL	23	2991.74			

CASES INCLUDED 24   MISSING CASES 0

Offutt AFB/RC-135
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	68.1439	4.43179	15.38	0.0000	
MONTH	-0.20804	0.60216	-0.35	0.7333	8.0
X1	-0.03741	0.85159	-0.04	0.9654	5.5
X2	-2.90198	5.91020	-0.49	0.6288	4.0

R-SQUARED	0.1656	RESID. MEAN SQUARE (MSE)	51.8517
ADJUSTED R-SQUARED	0.0404	STANDARD DEVIATION	7.20081

SOURCE	DF	SS	MS	F	P
REGRESSION	3	205.775	68.5917	1.32	0.2948
RESIDUAL	20	1037.03	51.8517		
TOTAL	23	1242.81			

CASES INCLUDED 24 MISSING CASES 0

Offutt AFB/RC-135
Reduced Model (1)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	68.8619	4.10734	16.77	0.0000	
MONTH	-0.37373	0.48964	-0.76	0.4538	5.5
X1	-0.06754	0.83388	-0.08	0.9362	5.5

R-SQUARED	0.1555	RESID. MEAN SQUARE (MSE)	49.9779
ADJUSTED R-SQUARED	0.0751	STANDARD DEVIATION	7.06950

SOURCE	DF	SS	MS	F	P
REGRESSION	2	193.274	96.6370	1.93	0.1695
RESIDUAL	21	1049.54	49.9779		
TOTAL	23	1242.81			

CASES INCLUDED 24 MISSING CASES 0

Offutt AFB/RC-135
Reduced Model (2)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	69.0909	2.91071	23.74	0.0000
MONTH	-0.40961	0.20371	-2.01	0.0568

R-SQUARED	0.1552	RESID. MEAN SQUARE (MSE)	47.7211
ADJUSTED R-SQUARED	0.1169	STANDARD DEVIATION	6.90804

SOURCE	DF	SS	MS	F	P
REGRESSION	1	192.946	192.946	4.04	0.0568
RESIDUAL	22	1049.86	47.7211		
TOTAL	23	1242.81			

CASES INCLUDED 24 MISSING CASES 0

Nellis AFB/HH-60
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	66.2439	4.82674	13.72	0.0000	
MONTH	0.48042	0.65583	0.73	0.4723	8.0
X1	-0.29196	0.92748	-0.31	0.7562	5.5
X2	-8.20897	6.43689	-1.28	0.2168	4.0

R-SQUARED	0.1095	RESID. MEAN SQUARE (MSE)	61.5053
ADJUSTED R-SQUARED	-0.0241	STANDARD DEVIATION	7.84253

SOURCE	DF	SS	MS	F	P
REGRESSION	3	151.184	50.3948	0.82	0.4984
RESIDUAL	20	1230.11	61.5053		
TOTAL	23	1381.29			

CASES INCLUDED 24 MISSING CASES 0

Nellis AFB/HH-60
Reduced Model (1)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	68.2749	4.62392	14.77	0.0000	
MONTH	0.01174	0.55122	0.02	0.9832	5.5
X1	-0.37717	0.93876	-0.40	0.6919	5.5

R-SQUARED	0.0370	RESID. MEAN SQUARE (MSE)	63.3399
ADJUSTED R-SQUARED	-0.0547	STANDARD DEVIATION	7.95863

SOURCE	DF	SS	MS	F	P
REGRESSION	2	51.1527	25.5763	0.40	0.6729
RESIDUAL	21	1330.14	63.3399		
TOTAL	23	1381.29			

CASES INCLUDED 24   MISSING CASES 0

Nellis AFB/HH-60
Reduced Model (2)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	69.5540	3.28884	21.15	0.0000
MONTH	-0.18865	0.23017	-0.82	0.4212

R-SQUARED	0.0296	RESID. MEAN SQUARE (MSE)	60.9255
ADJUSTED R-SQUARED	-0.0145	STANDARD DEVIATION	7.80548

SOURCE	DF	SS	MS	F	P
REGRESSION	1	40.9281	40.9281	0.67	0.4212
RESIDUAL	22	1340.36	60.9255		
TOTAL	23	1381.29			

CASES INCLUDED 24   MISSING CASES 0

Moody AFB/HH-60
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	73.0530	5.53908	13.19	0.0000	
MONTH	0.12133	0.75261	0.16	0.8735	8.0
X1	-0.19685	1.06436	-0.18	0.8551	5.5
X2	-15.7681	7.38686	-2.13	0.0454	4.0

R-SQUARED	0.4743	RESID. MEAN SQUARE (MSE)	80.9989
ADJUSTED R-SQUARED	0.3954	STANDARD DEVIATION	8.99994

SOURCE	DF	SS	MS	F	P
REGRESSION	3	1461.52	487.174	6.01	0.0043
RESIDUAL	20	1619.98	80.9989		
TOTAL	23	3081.50			

CASES INCLUDED 24 MISSING CASES 0

Hollomon AFB/HH-60
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	77.3894	6.35955	12.17	0.0000	
MONTH	0.29266	0.86409	0.34	0.7384	8.0
X1	1.81538	1.22201	1.49	0.1530	5.5
X2	-33.0786	8.48103	-3.90	0.0009	4.0

R-SQUARED	0.5434	RESID. MEAN SQUARE (MSE)	106.772
ADJUSTED R-SQUARED	0.4749	STANDARD DEVIATION	10.3330

SOURCE	DF	SS	MS	F	P
REGRESSION	3	2541.64	847.215	7.93	0.0011
RESIDUAL	20	2135.43	106.772		
TOTAL	23	4677.08			

CASES INCLUDED 24 MISSING CASES 0

Tinker AFB/E-3
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	58.0333	4.88628	11.88	0.0000	
MONTH	-1.40769	0.66391	-2.12	0.0467	8.0
X1	0.65105	0.93892	0.69	0.4960	5.5
X2	-9.72284	6.51629	-1.49	0.1513	4.0

R-SQUARED	0.7278	RESID. MEAN SQUARE (MSE)	63.0320
ADJUSTED R-SQUARED	0.6870	STANDARD DEVIATION	7.93927

SOURCE	DF	SS	MS	F	P
REGRESSION	3	3371.32	1123.77	17.83	0.0000
RESIDUAL	20	1260.64	63.0320		
TOTAL	23	4631.96			

CASES INCLUDED 24   MISSING CASES 0

Tinker AFB/E-3
Reduced Model (1)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	60.4388	4.74543	12.74	0.0000	
MONTH	-1.96280	0.56571	-3.47	0.0023	5.5
X1	0.55012	0.96343	0.57	0.5741	5.5

R-SQUARED	0.6975	RESID. MEAN SQUARE (MSE)	66.7128
ADJUSTED R-SQUARED	0.6687	STANDARD DEVIATION	8.16779

SOURCE	DF	SS	MS	F	P
REGRESSION	2	3230.99	1615.50	24.22	0.0000
RESIDUAL	21	1400.97	66.7128		
TOTAL	23	4631.96			

CASES INCLUDED 24   MISSING CASES 0

Tinker AFB/E-3
Reduced Model (2)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	58.5732	3.38838	17.29	0.0000
MONTH	-1.67052	0.23714	-7.04	0.0000

R-SQUARED	0.6928	RESID. MEAN SQUARE (MSE)	64.6690
ADJUSTED R-SQUARED	0.6789	STANDARD DEVIATION	8.04171

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3209.24	3209.24	49.63	0.0000
RESIDUAL	22	1422.72	64.6690		
TOTAL	23	4631.96			

CASES INCLUDED 24   MISSING CASES 0

Davis-Montham/A-10
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	70.9485	3.31656	21.39	0.0000	
MONTH	0.28357	0.45063	0.63	0.5363	8.0
X1	-2.29545	0.63729	-3.60	0.0018	5.5
X2	0.45932	4.42293	0.10	0.9183	4.0

R-SQUARED	0.6951	RESID. MEAN SQUARE (MSE)	29.0389
ADJUSTED R-SQUARED	0.6494	STANDARD DEVIATION	5.38877

SOURCE	DF	SS	MS	F	P
REGRESSION	3	1324.04	441.346	15.20	0.0000
RESIDUAL	20	580.777	29.0389		
TOTAL	23	1904.82			

CASES INCLUDED 24   MISSING CASES 0

Davis-Montham/A-10
Reduced Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	70.8348	3.05621	23.18	0.0000	
MONTH	0.30979	0.36434	0.85	0.4048	5.5
X1	-2.29069	0.62048	-3.69	0.0014	5.5

R-SQUARED	0.6949	RESID. MEAN SQUARE (MSE)	27.6710
ADJUSTED R-SQUARED	0.6659	STANDARD DEVIATION	5.26032

SOURCE	DF	SS	MS	F	P
REGRESSION	2	1323.73	661.863	23.92	0.0000
RESIDUAL	21	581.090	27.6710		
TOTAL	23	1904.82			

CASES INCLUDED 24 MISSING CASES 0

Pope AFB/A-10
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	62.2985	2.89167	21.54	0.0000	
MONTH	0.03741	0.39290	0.10	0.9251	8.0
X1	-0.05490	0.55565	-0.10	0.9223	5.5
X2	-7.31713	3.85631	-1.90	0.0723	4.0

R-SQUARED	0.4152	RESID. MEAN SQUARE (MSE)	22.0751
ADJUSTED R-SQUARED	0.3275	STANDARD DEVIATION	4.69841

SOURCE	DF	SS	MS	F	P
REGRESSION	3	313.448	104.483	4.73	0.0118
RESIDUAL	20	441.502	22.0751		
TOTAL	23	754.950			

CASES INCLUDED 24 MISSING CASES 0

Pope AFB/A-10
Reduced Model (1)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	64.1088	2.89382	22.15	0.0000	
MONTH	-0.38035	0.34498	-1.10	0.2827	5.5
X1	-0.13085	0.58751	-0.22	0.8259	5.5

R-SQUARED	0.3099	RESID. MEAN SQUARE (MSE)	24.8085
ADJUSTED R-SQUARED	0.2442	STANDARD DEVIATION	4.98082

SOURCE	DF	SS	MS	F	P
REGRESSION	2	233.971	116.985	4.72	0.0203
RESIDUAL	21	520.979	24.8085		
TOTAL	23	754.950			

CASES INCLUDED 24   MISSING CASES 0

Pope AFB/A-10
Reduced Model (2)

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	64.5525	2.05284	31.45	0.0000
MONTH	-0.44987	0.14367	-3.13	0.0049

R-SQUARED	0.3083	RESID. MEAN SQUARE (MSE)	23.7368
ADJUSTED R-SQUARED	0.2768	STANDARD DEVIATION	4.87204

SOURCE	DF	SS	MS	F	P
REGRESSION	1	232.740	232.740	9.81	0.0049
RESIDUAL	22	522.210	23.7368		
TOTAL	23	754.950			

CASES INCLUDED 24   MISSING CASES 0

Nellis AFB/A-10
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	80.0258	3.62777	22.06	0.0000	
MONTH	-0.75524	0.49292	-1.53	0.1411	8.0
X1	0.96259	0.69709	1.38	0.1826	5.5
X2	-11.4855	4.83795	-2.37	0.0277	4.0

R-SQUARED	0.6540	RESID. MEAN SQUARE (MSE)	34.7443
ADJUSTED R-SQUARED	0.6021	STANDARD DEVIATION	5.89443

SOURCE	DF	SS	MS	F	P
REGRESSION	3	1313.22	437.742	12.60	0.0001
RESIDUAL	20	694.885	34.7443		
TOTAL	23	2008.11			

CASES INCLUDED 24   MISSING CASES 0

Moody AFB/A-10
Full Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	74.2030	4.09261	18.13	0.0000	
MONTH	0.07902	0.55608	0.14	0.8884	8.0
X1	-1.68986	0.78641	-2.15	0.0441	5.5
X2	-6.20583	5.45786	-1.14	0.2690	4.0

R-SQUARED	0.6885	RESID. MEAN SQUARE (MSE)	44.2185
ADJUSTED R-SQUARED	0.6418	STANDARD DEVIATION	6.64970

SOURCE	DF	SS	MS	F	P
REGRESSION	3	1954.70	651.567	14.74	0.0000
RESIDUAL	20	884.369	44.2185		
TOTAL	23	2839.07			

CASES INCLUDED 24   MISSING CASES 0

Moody AFB/A-10
Reduced Model

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RATE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	75.7384	3.89028	19.47	0.0000	
MONTH	-0.27529	0.46377	-0.59	0.5591	5.5
X1	-1.75428	0.78982	-2.22	0.0375	5.5

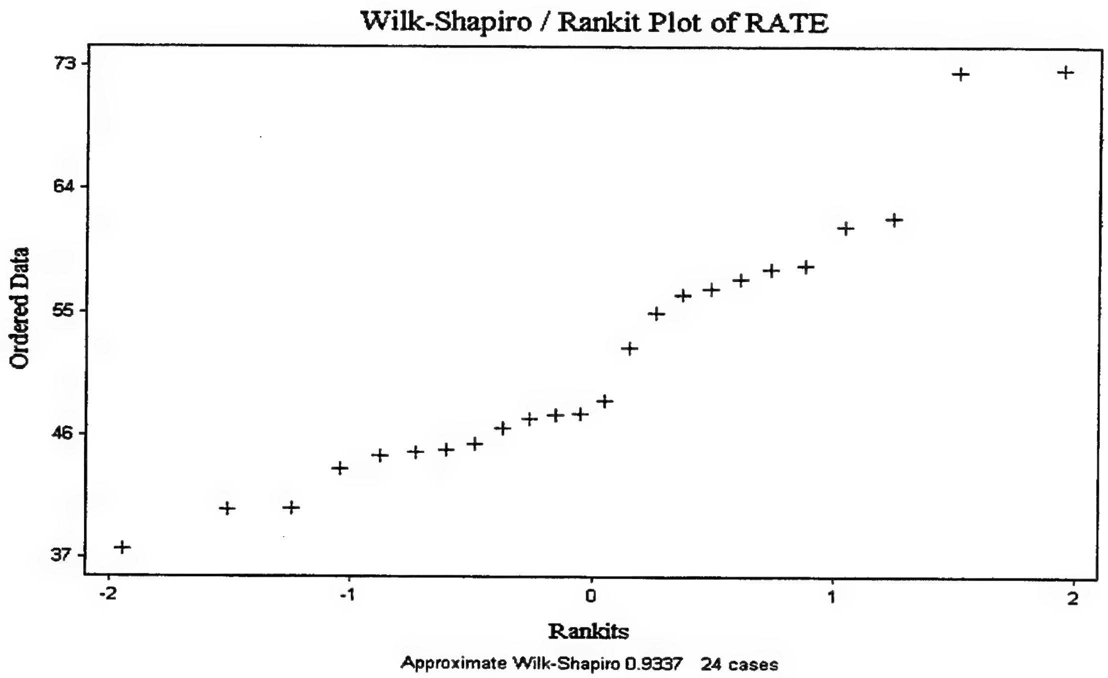
R-SQUARED	0.6684	RESID. MEAN SQUARE (MSE)	44.8352
ADJUSTED R-SQUARED	0.6368	STANDARD DEVIATION	6.69591

SOURCE	DF	SS	MS	F	P
REGRESSION	2	1897.53	948.766	21.16	0.0000
RESIDUAL	21	941.538	44.8352		
TOTAL	23	2839.07			

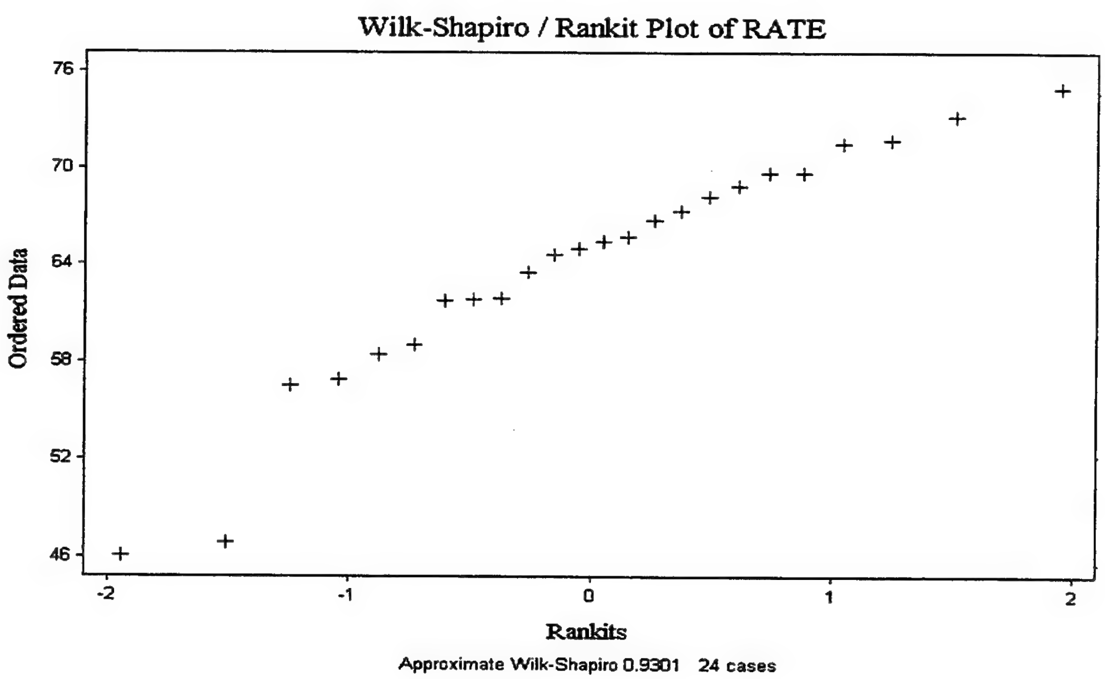
CASES INCLUDED 24 MISSING CASES 0

Appendix D: Rankit Plots

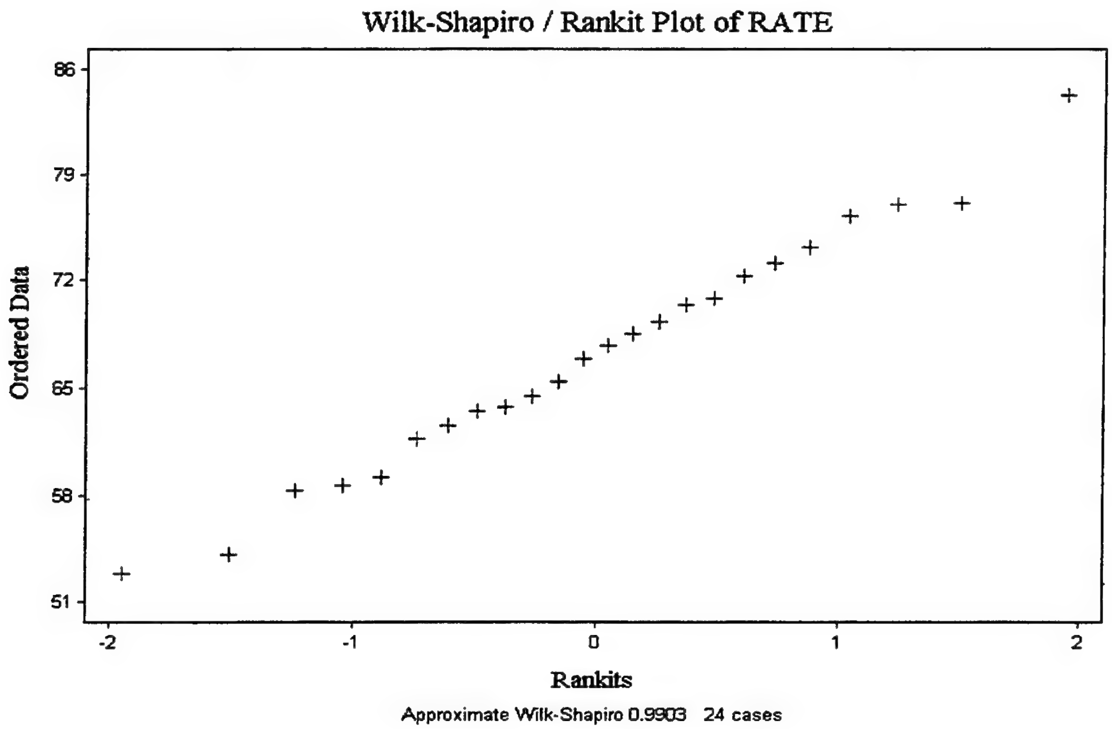
Mountain Home AFB/F-15



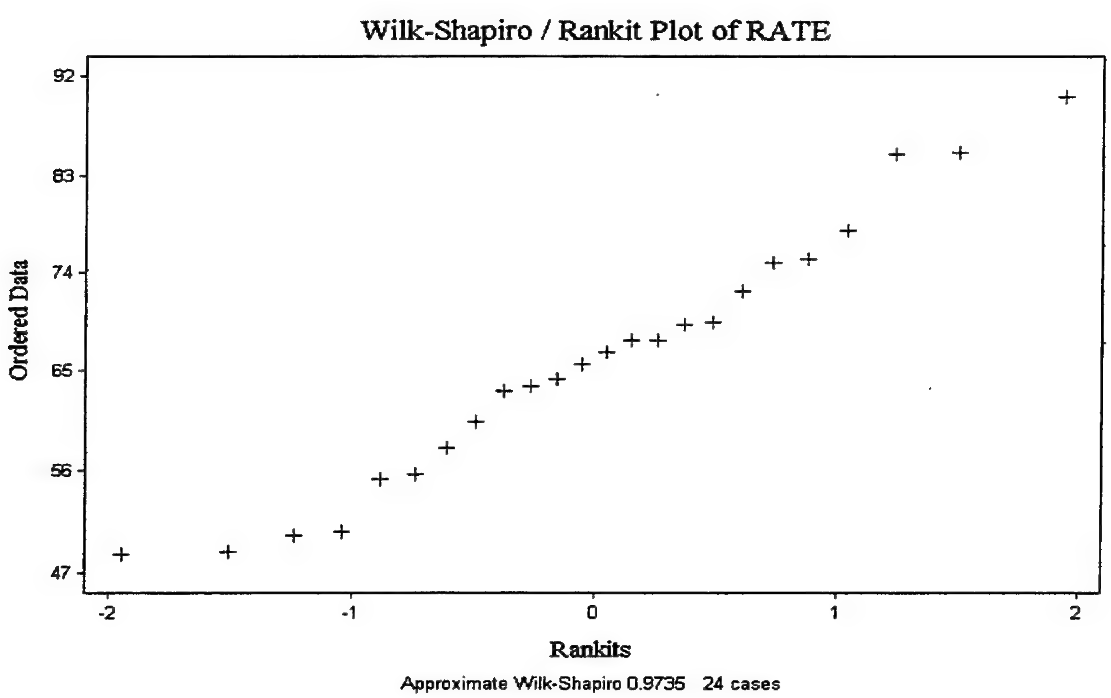
OffuttAFB/RC-135



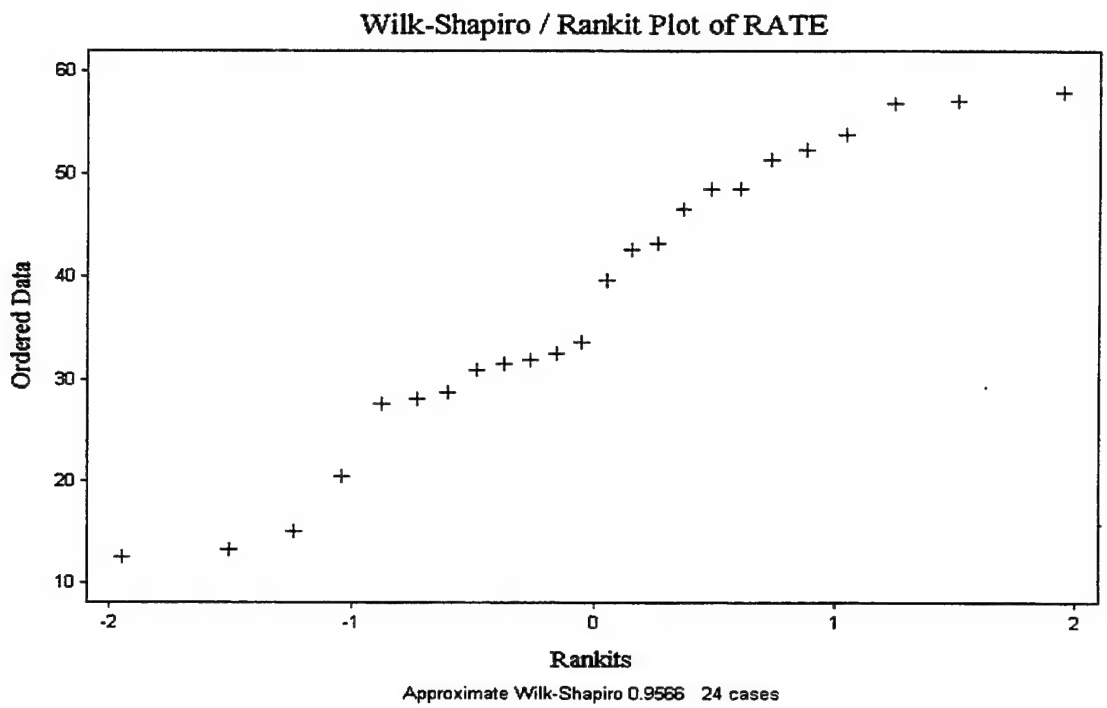
Nellis AFB/HH-60



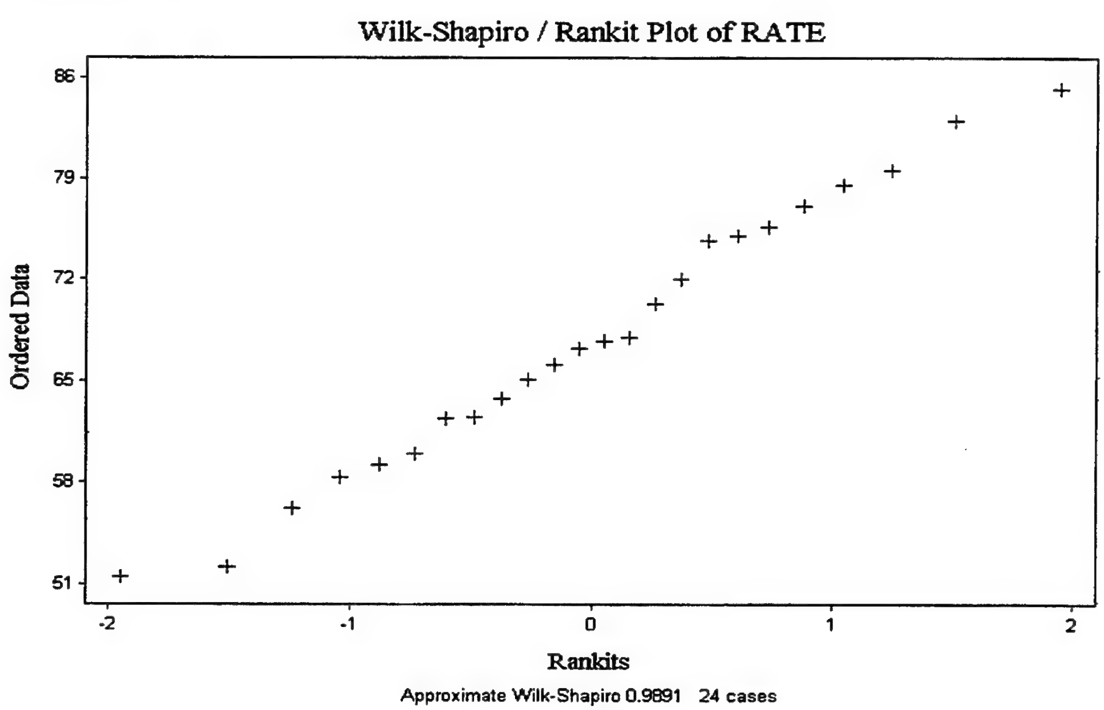
Moody AFB/HH-60



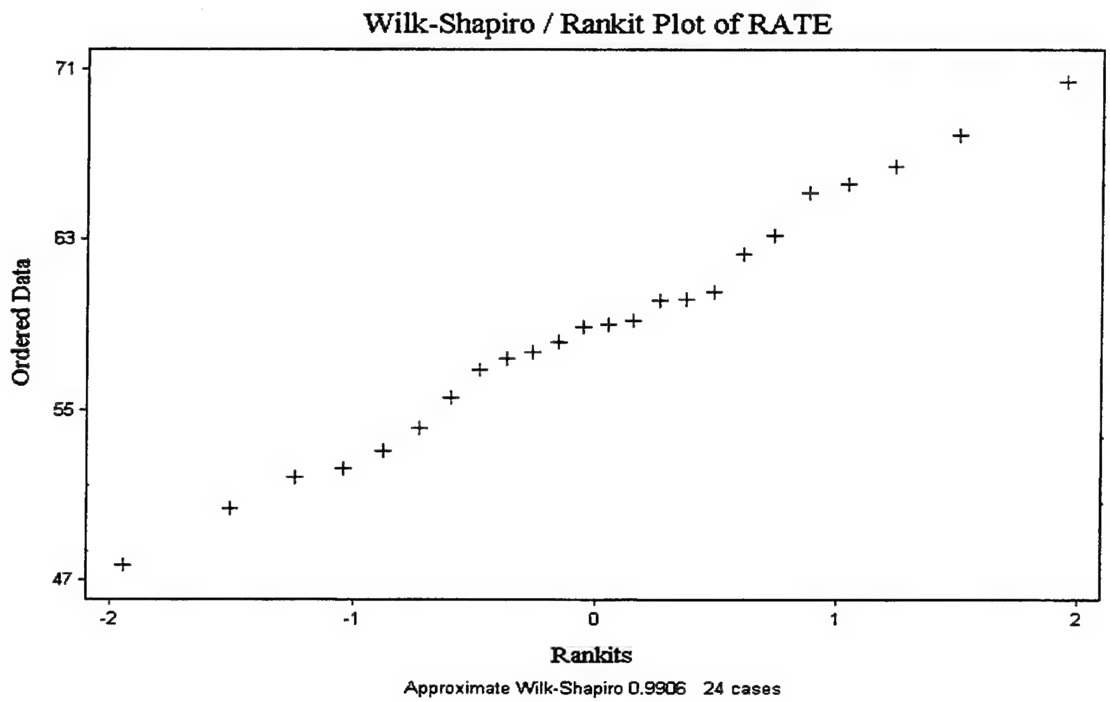
Tinker AFB/E-3



Nellis AFB/A-10



Pope AFB/A-10



Wilk-Shapiro / Rankit Plot of RATE
Ordered Data
71
63
55
47
-2
-1
0
1
2
Rankits
Approximate Wilk-Shapiro 0.9906 24 cases

Appendix E: Two-Sample T-Tests

Mountain Home AFB/F-15

TWO-SAMPLE T TESTS FOR RATE BY PERIOD

YEAR	MEAN	SAMPLE SIZE	S.D.	S.E.
1	46.175	12	5.7093	1.6481
2	57.350	12	9.2286	2.6641
DIFFERENCE	-11.175			

NULL HYPOTHESIS: DIFFERENCE = 0
ALTERNATIVE HYP: DIFFERENCE <> 0

ASSUMPTION	T	DF	P	95% CI FOR DIFFERENCE
EQUAL VARIANCES	-3.57	22	0.0017	(-17.672, -4.6783)
UNEQUAL VARIANCES	-3.57	18.3	0.0021	(-17.748, -4.6024)

	F	NUM DF	DEN DF	P
TESTS FOR EQUALITY OF VARIANCES	2.61	11	11	0.0631

CASES INCLUDED 24 MISSING CASES 0

Offutt AFB/RC-135

TWO-SAMPLE T TESTS FOR RATE BY PERIOD

PERIOD	MEAN	SAMPLE SIZE	S.D.	S.E.
1	66.792	12	4.6572	1.3444
2	61.150	12	8.5984	2.4821
DIFFERENCE	5.6417			

NULL HYPOTHESIS: DIFFERENCE = 0
ALTERNATIVE HYP: DIFFERENCE <> 0

ASSUMPTION	T	DF	P	95% CI FOR DIFFERENCE
EQUAL VARIANCES	2.00	22	0.0582	(-0.2126, 11.496)
UNEQUAL VARIANCES	2.00	16.9	0.0620	(-0.3156, 11.599)

	F	NUM DF	DEN DF	P
TESTS FOR EQUALITY OF VARIANCES	3.41	11	11	0.0267

CASES INCLUDED 24 MISSING CASES 0

Nellis AFB/HH-60

TWO-SAMPLE T TESTS FOR RATE BY PERIOD

PERIOD	MEAN	SAMPLE SIZE	S.D.	S.E.
1	69.367	12	7.4985	2.1646
2	65.025	12	7.6852	2.2185
DIFFERENCE	4.3417			

NULL HYPOTHESIS: DIFFERENCE = 0
ALTERNATIVE HYP: DIFFERENCE <> 0

ASSUMPTION	T	DF	P	95% CI FOR DIFFERENCE
EQUAL VARIANCES	1.40	22	0.1752	(-2.0865, 10.770)
UNEQUAL VARIANCES	1.40	22.0	0.1753	(-2.0867, 10.770)

	F	NUM DF	DEN DF	P
TESTS FOR EQUALITY OF VARIANCES	1.05	11	11	0.4682

CASES INCLUDED 24   MISSING CASES 0

Moody AFB/HH-60

TWO-SAMPLE T TESTS FOR RATE BY PERIOD

PERIOD	MEAN	SAMPLE SIZE	S.D.	S.E.
1	73.842	12	9.6701	2.7915
2	58.250	12	7.3501	2.1218
DIFFERENCE	15.592			

NULL HYPOTHESIS: DIFFERENCE = 0
ALTERNATIVE HYP: DIFFERENCE <> 0

ASSUMPTION	T	DF	P	95% CI FOR DIFFERENCE
EQUAL VARIANCES	4.45	22	0.0002	(8.3199, 22.863)
UNEQUAL VARIANCES	4.45	20.5	0.0002	(8.2896, 22.894)

	F	NUM DF	DEN DF	P
TESTS FOR EQUALITY OF VARIANCES	1.73	11	11	0.1883

CASES INCLUDED 24   MISSING CASES 0

Tinker AFB/E-3

TWO-SAMPLE T TESTS FOR RATE BY PERIOD

PERIOD	MEAN	SAMPLE SIZE	S.D.	S.E.
1	48.883	12	7.8081	2.2540
2	26.500	12	9.3188	2.6901
DIFFERENCE	22.383			

NULL HYPOTHESIS: DIFFERENCE = 0
ALTERNATIVE HYP: DIFFERENCE <> 0

ASSUMPTION	T	DF	P	95% CI FOR DIFFERENCE
EQUAL VARIANCES	6.38	22	0.0000	(15.105, 29.662)
UNEQUAL VARIANCES	6.38	21.3	0.0000	(15.092, 29.675)

	F	NUM DF	DEN DF	P
TESTS FOR EQUALITY OF VARIANCES	1.42	11	11	0.2837

CASES INCLUDED 24 MISSING CASES 0

Nellis AFB/A-10

TWO-SAMPLE T TESTS FOR RATE BY PERIOD

PERIOD	MEAN	SAMPLE SIZE	S.D.	S.E.
1	75.117	12	6.3604	1.8361
2	60.825	12	5.5400	1.5992
DIFFERENCE	14.292			

NULL HYPOTHESIS: DIFFERENCE = 0
ALTERNATIVE HYP: DIFFERENCE <> 0

ASSUMPTION	T	DF	P	95% CI FOR DIFFERENCE
EQUAL VARIANCES	5.87	22	0.0000	(9.2420, 19.341)
UNEQUAL VARIANCES	5.87	21.6	0.0000	(9.2365, 19.347)

	F	NUM DF	DEN DF	P
TESTS FOR EQUALITY OF VARIANCES	1.32	11	11	0.3274

CASES INCLUDED 24 MISSING CASES 0

Pope AFB/A-10

TWO-SAMPLE T TESTS FOR RATE BY PERIOD

PERIOD	MEAN	SAMPLE SIZE	S.D.	S.E.
1	62.542	12	4.5626	1.3171
2	55.317	12	4.3979	1.2696
DIFFERENCE	7.2250			

NULL HYPOTHESIS: DIFFERENCE = 0
ALTERNATIVE HYP: DIFFERENCE <> 0

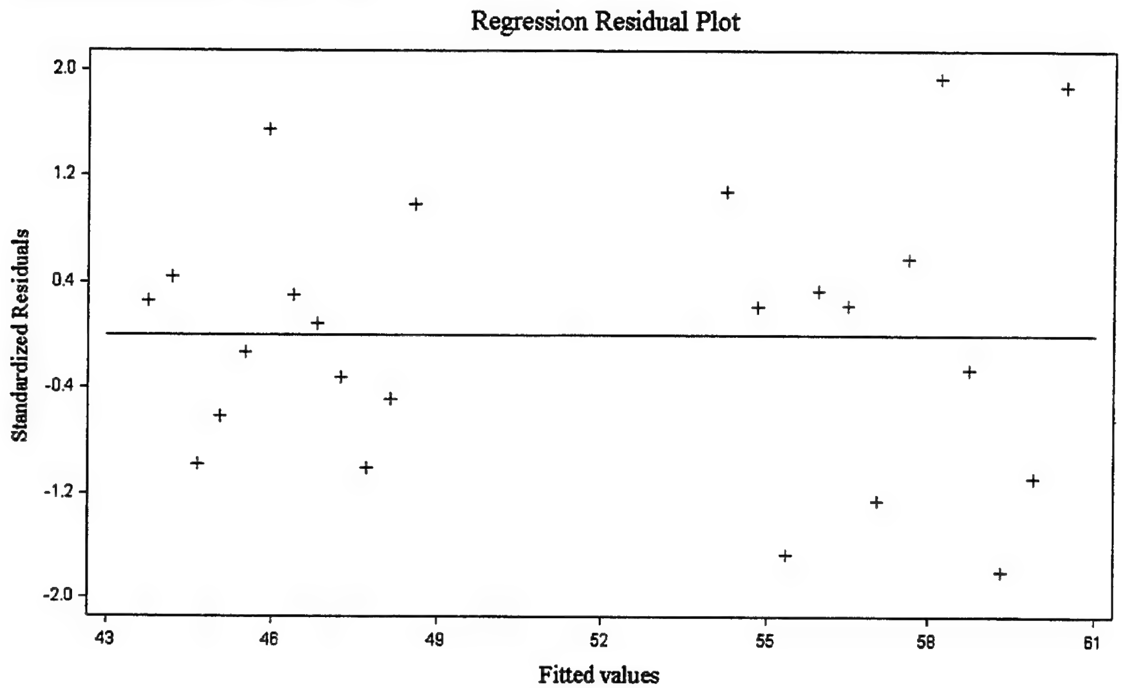
ASSUMPTION	T	DF	P	95% CI FOR DIFFERENCE
EQUAL VARIANCES	3.95	22	0.0007	(3.4311, 11.019)
UNEQUAL VARIANCES	3.95	22.0	0.0007	(3.4308, 11.019)

	F	NUM DF	DEN DF	P
TESTS FOR EQUALITY OF VARIANCES	1.08	11	11	0.4526

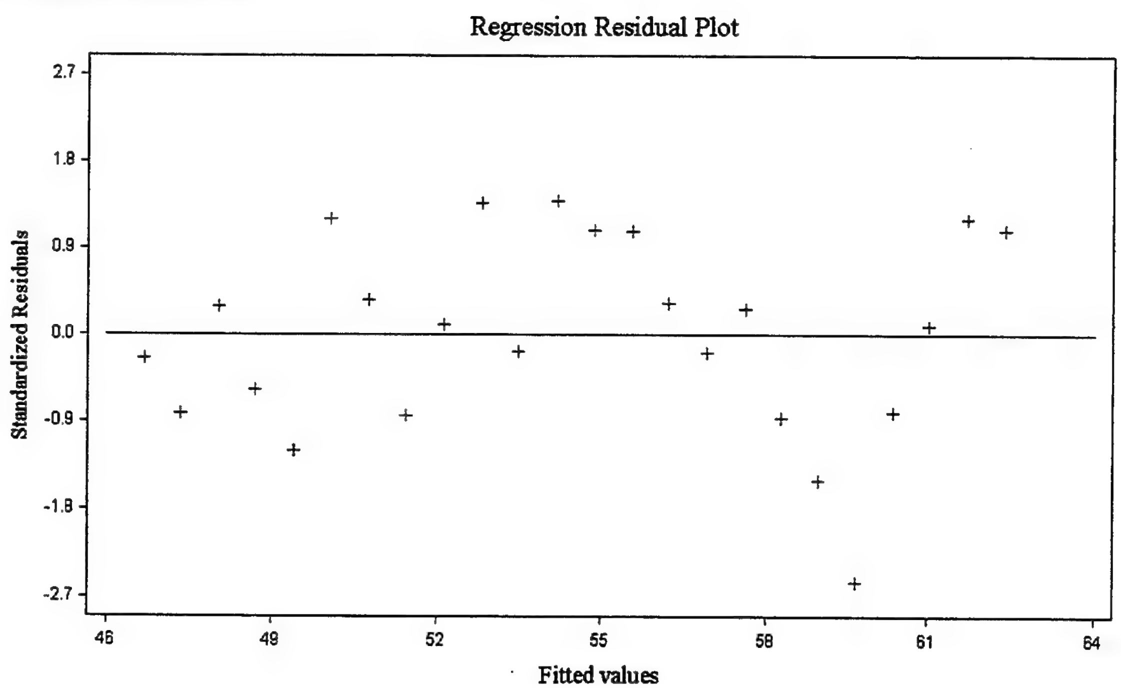
CASES INCLUDED 24 MISSING CASES 0

Appendix F: Regression Residual Plots

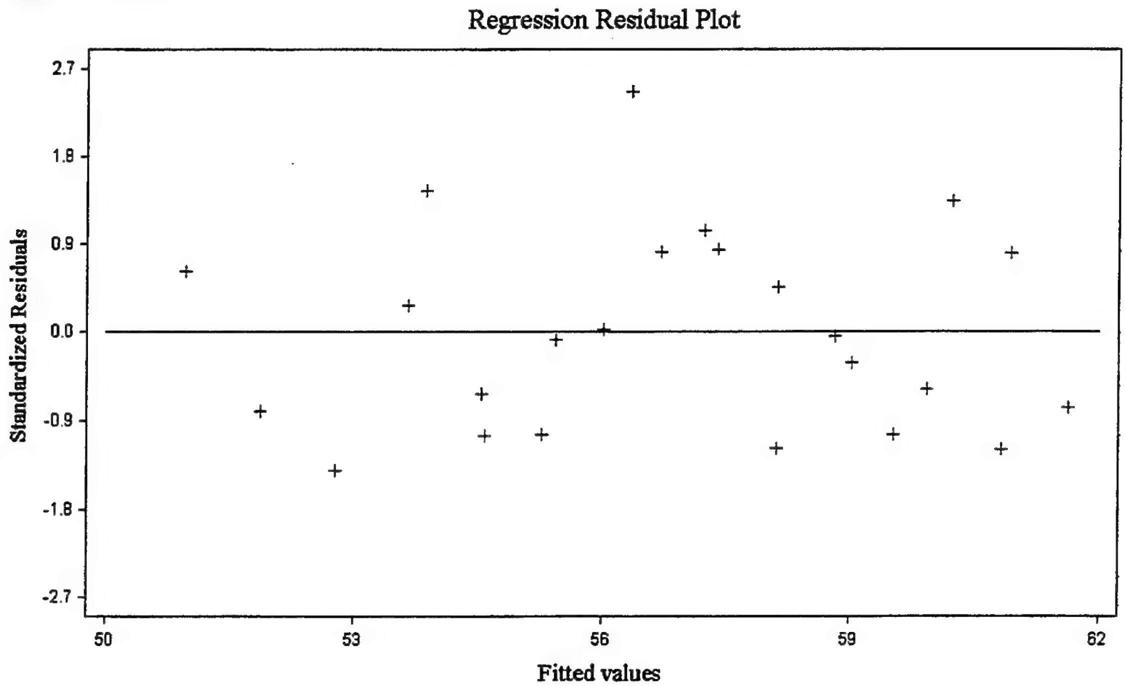
Mountain Home AFB/F-15



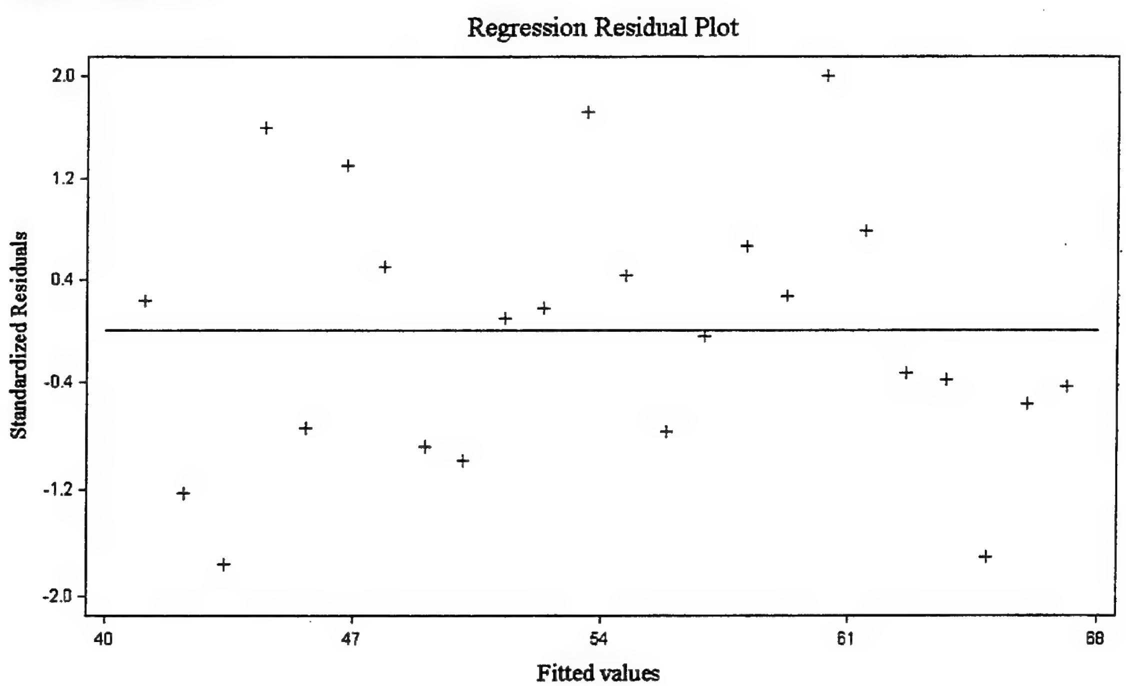
Langley AFB/F-15



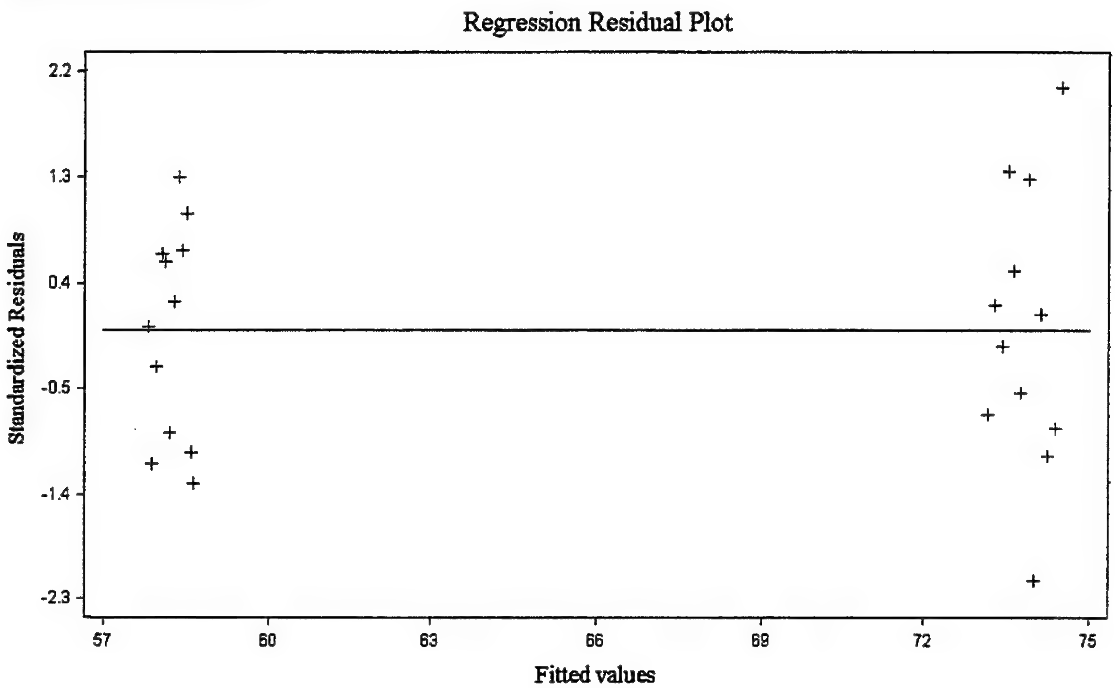
Eglin AFB/F-15



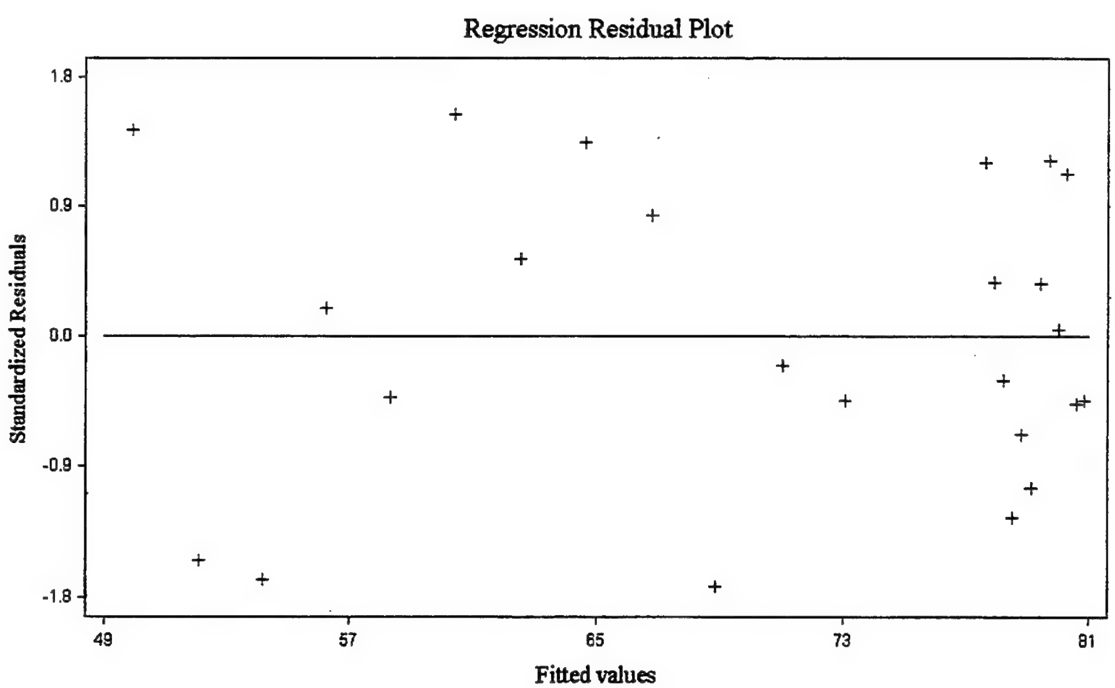
Nellis AFB/F-15



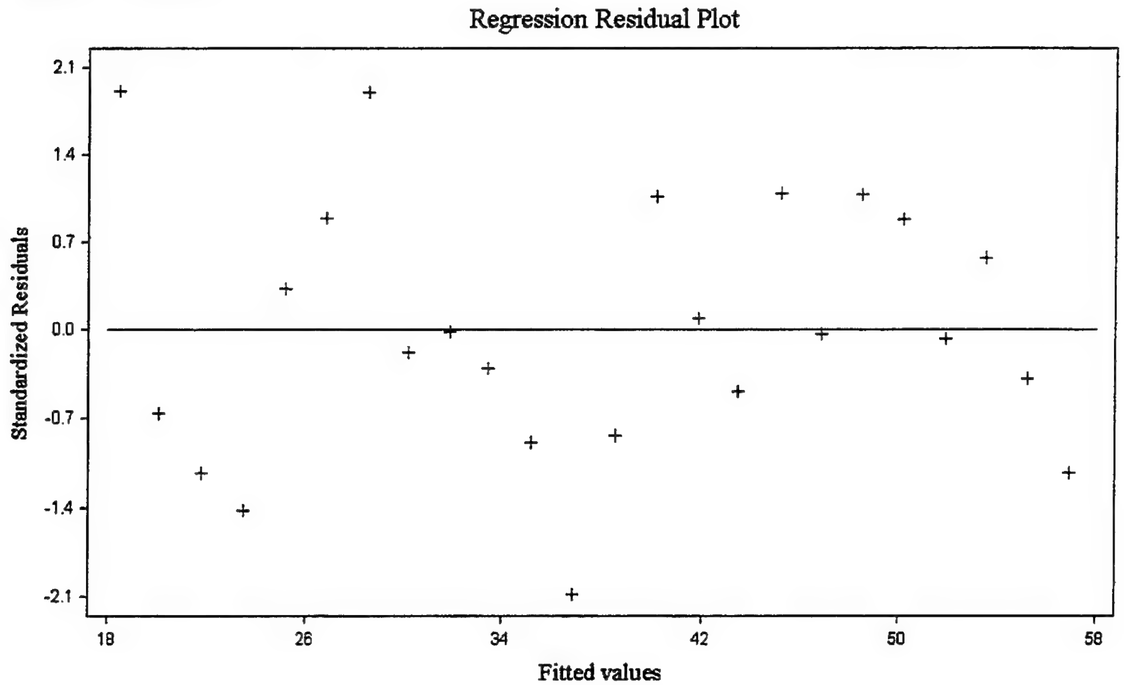
Moody AFB/HH-60



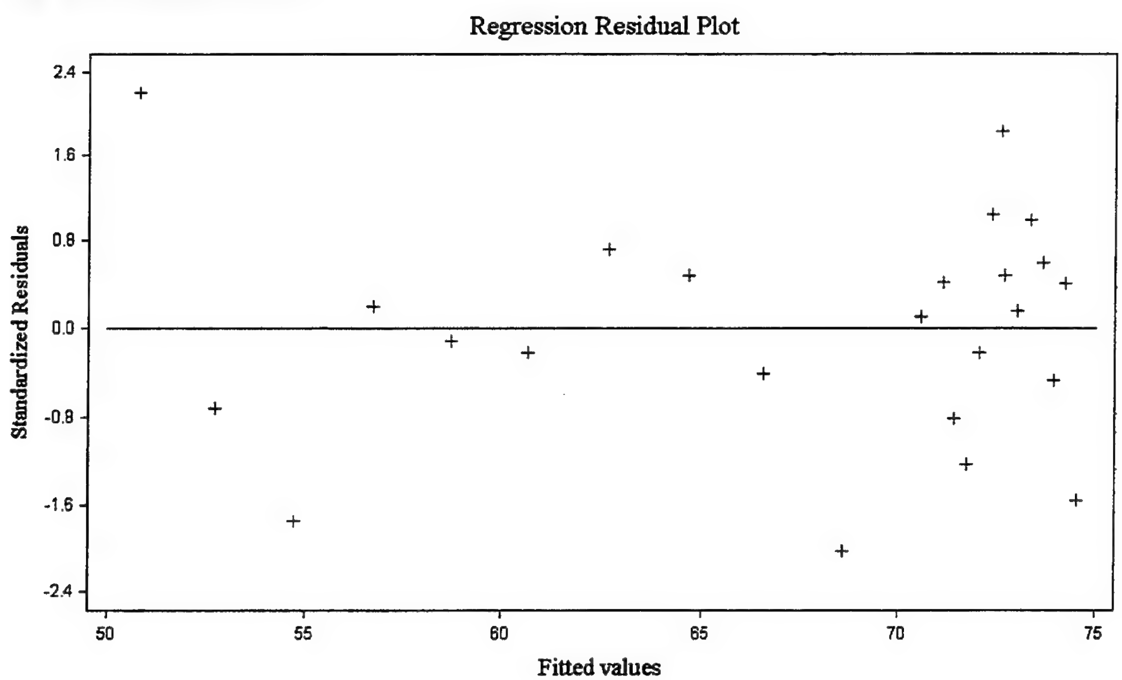
Hollomon AFB/HH-60



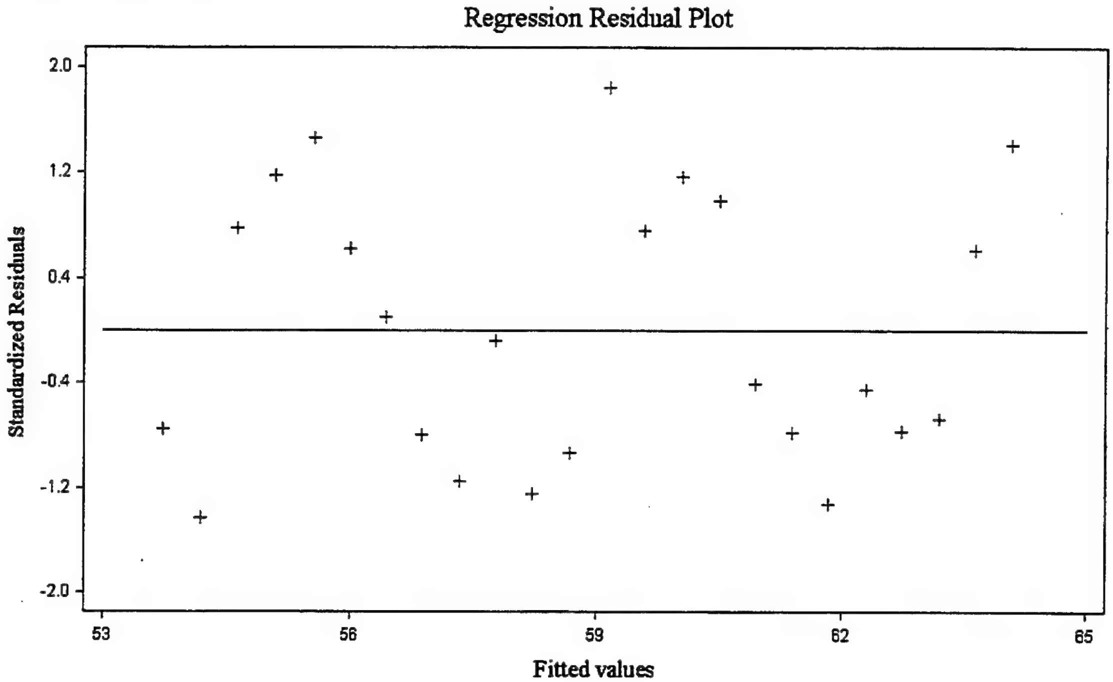
Tinker AFB/E-3



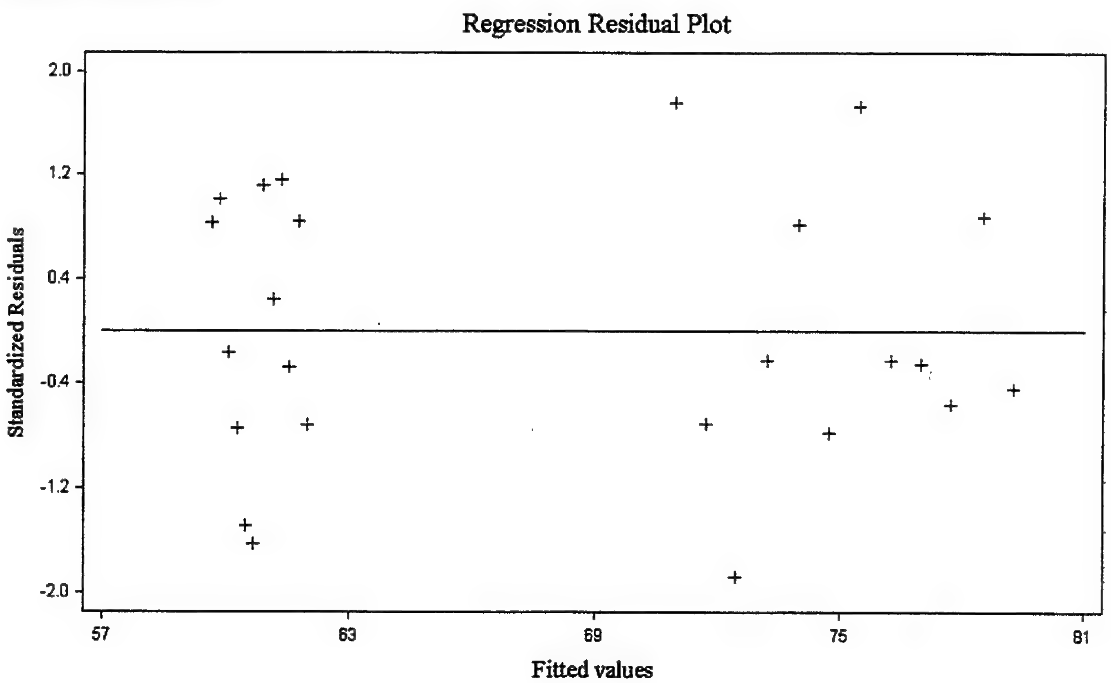
Davis-Montham/A-10



Pope AFB/A-10



Nellis AFB/A-10



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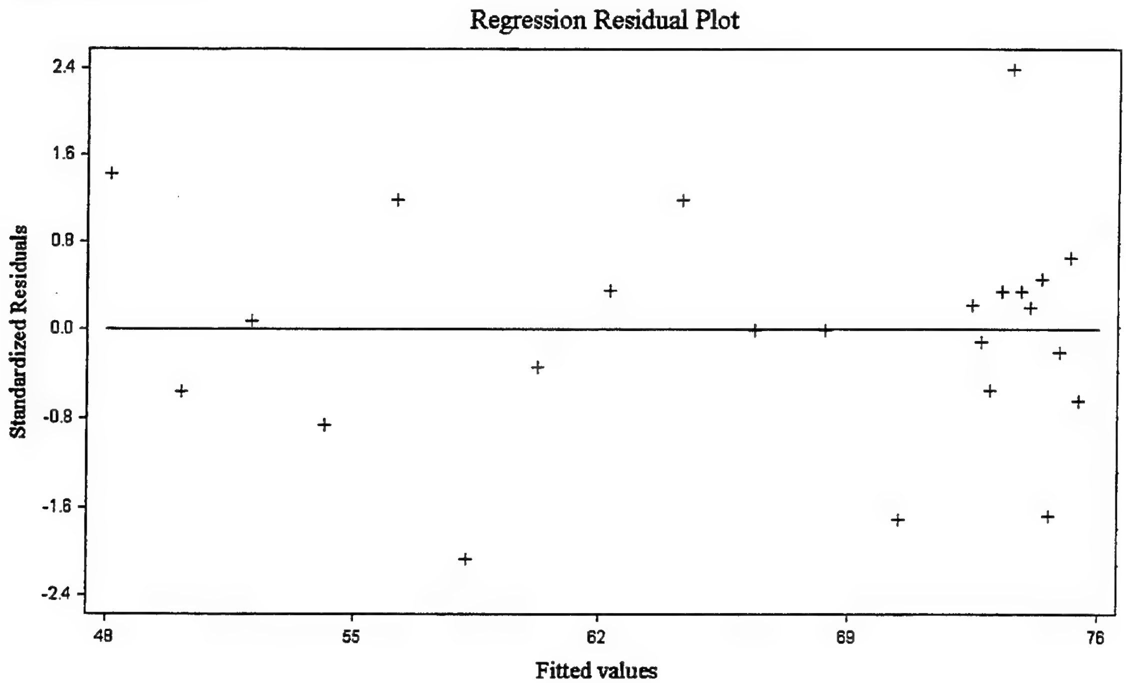

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Vita

Lieutenant Allison was born on 27 March 1963, in Bangor, Maine. He attended Vanderbilt University (1980-1981), Ohio State University (1981-1983), and Victor Valley Community College (1986-1987), after which he received the first of his two Associates of Science degrees. He earned his Bachelor of Science degree in Professional Aeronautics from Embry-Riddle Aeronautical University in 1995.

Lieutenant Allison entered the Air Force in 1984, completing basic training at Lackland AFB, Texas and technical training at Chanute AFB, Illinois, and was then assigned to George AFB, California in October 1984. In November 1988, Lt Allison was assigned to RAF Woodbridge, United Kingdom where he participated in temporary duty assignments to Incirlik AB, Turkey in support of Operations DESERT SHIELD, DESERT STORM, and PROVIDE COMFORT. In November 1991, Lt Allison was assigned to Eglin AFB, Florida. In February 1996, he entered Officer Training School (OTS) at Maxwell AFB, Alabama. He was commissioned a Second Lieutenant with a Regular commission in May 1996, after finishing as a Distinguished Graduate of OTS. He then attended the Aircraft Maintenance Officer Course, Sheppard AFB, Texas, and again finished as a Distinguished Graduate. He was then assigned to Dyess AFB, Texas. He then attended the Air Force Institute of Technology at Wright-Patterson AFB, Ohio to pursue his Masters degree. Lt Allison's next assignment is at Robins AFB, Georgia.

Lieutenant Allison is married to the former Constance McKee of Dayton, Ohio. They have two sons, Michael, thirteen, and Matthew, nine years old.

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13. ABSTRACT *(Maximum 200 words)*

Previous studies concerning quality improvement and the Action Workout Process attempted to define and describe the difficult concept of quality. A logical next step is to study to what extent implementation of a quality improvement program, such as ACC's Action Workout Process, positively or negatively affects performance factors within an Air Force organization.

This study focused on exploring the fundamental question of whether there was, as a result of the Action Workout, a noticeable, statistically verifiable, positive or negative change in the mission capability of aircraft assigned to the units carrying out this quality improvement initiative.

Research questions were developed and data analysis conducted to determine if the effects of the Action Workout could be quantified and measured and if the Action Workout was an effective means of improving aircraft performance. While the results of this study did not unequivocably endorse the Action Workout Process, the results do indicate performance at several bases was enhanced after implementation of this quality improvement process. Using these results as a baseline, future researchers can now take the next step - a fuller understanding and quantification of the effects of quality improvement processes, such as the Action Workout, on organizational performance.

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